

The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

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NOTES AND COMMENTS

The End of an Era

THE decision to demolish the two towers of the Crystal Palace, all that remained of the building after the fire of 1936, is a progressive step of the first importance. It is not merely that the structure of the towers will provide some 1600 tons of iron for munition-making; the demolition of this fragmentary monument is far more important from a social and symbolic point of view. The Crystal Palace was the concrete expression of the philosophy of the mid-19th century—a philosophy that thought of “progress” as little more than the erection of bigger and better Crystal Palaces. We Europeans of 1940 know only too well what that philosophy, with its regimentation of masses of men and material, has led to. Sir Max Beerbolm has expressed the position, far more vividly than any words can compass, in his famous cartoon in which the 18th, 19th, and 20th centuries look at the future. Londoners may sentimentalise a little at the loss of an old landmark, but only for a moment if they happen to be in the chemical industry. The end of the Crystal Palace marks the last of an era in which great size and loud noise were reckoned as goals to aim at. The German war-machine is the quintessence of this material philosophy. The chemical worker has only to contrast the dirty, noisy workshop of the old days with the silent laboratory of the present, in which operations of far greater magnitude are performed, to appreciate the difference in the real trend of to-day; plastics and nylon are superseding cast iron. Incidental interest, by the way, is added to the demolition, as it is being carried out by the famous firm of George Cohen, Sons and Co., who have salvaged so much material for the chemical industry.

Preparedness

OTHER industries in this country have met the impact of war conditions with greater or less effectiveness, but there seems no doubt that the British chemical industry as a whole may congratulate itself on the steps which its members have taken, both before and during the war, to deal with the exceptional problems arising and likely to arise. It is easy enough to blow your own trumpet; but favourable comment from an unprejudiced source is really much more encouraging. The following passage is quoted from an article in *Commerce Reports* by an American consular official in England, and states the position calmly and dispassionately. “With the passage of the first quarter of 1940 it became increasingly apparent that the British chemical industry had transposed itself to a war-time footing with speed, and with an ease which betokened long preparation for possible changes and intensification of effort. All indications point to the conclusion that the increased tempo in the industry in the last

quarter of 1939 has been well maintained in the current year. . . . The primary necessity of keeping the industrial machine running smoothly in time of war would seem to depend to a large degree upon the regular supply of chemicals and allied products to the consuming industries. There does not seem much doubt that this will be possible, in the absence of unforeseen circumstances, since no shortage of essential materials has been reported or is anticipated. Chemical manufacturers and consumers recall the position during 1914-18 when there was an acute shortage of dyes and medicines, and a scarcity of other essential chemical products. It is understood that every possible precaution has been taken to prevent such a situation from occurring during the present period of hostilities. The sections of the chemical industry which were founded during the period 1914-18 to supply essential needs have been maintained since then and have thus played a part in the state of preparedness with which the chemical industry faced the present war. . . . There has been no diminution in the effort of the chemical industry to make as great a contribution as possible to the conduct of the war, to the maintenance of civil life on as normal a plane as possible, and to the drive for increased exports to help pay for purchases of other essential goods in foreign markets.”

Industry in the Front Line

THE Battles of Belgium and France have been fought and lost. Now is the eve of the Battle of Britain, which will decide the future of European civilisation. The nation is united and determined as never before in its history, and the final issue clearly depends on its remaining so. The Belgian and French capitulations have betrayed a breakdown of civilian morale as well as a material collapse. The British people, in entering upon their tremendous ordeal, have to face the fact that everything that has happened since last September has been accepted by the enemy as a complete vindication of his contention that the democracies of Europe were inefficient, flabby and virtually effete. It is an article of faith, publicly proclaimed by Ribbentrop after his sojourn at the London Embassy, that the British nation is in no better case than its defeated allies and associates. It is there as much as in actual armed defence that the Nazis have got to be proved wrong. The soldiers, sailors and airmen have already shown in combat that there will be no failure on their part. The morale of the civilian population is still largely untested, and it is now the privilege of the women and the men beyond military age or for the present in reserved occupations to sustain whatever blows the enemy may be preparing for them as if they, too, were an integral part of the fighting front. Great Britain, in fact, falls

back as never before on her industrial lines of defence. It is a proud moment, and the post is one of great honour. It is not to be conceived that the leaders and workers in the far-famed structure of British industry will fail to justify the confidence publicly proclaimed in their courage and resolution by the Government and the fighting forces.

Canadian Charcoal

COMMENT in the *Commerce Intelligence Journal* of the Canadian Department of Trade and Commerce suggests that there are openings in the British market for Canadian charcoal, now that supplies from Germany and Scandinavia, the normal source of British charcoal imports, are cut off. From correspondence which Liverpool firms have already received from a few Canadian firms interested in charcoal, it appears that most of the charcoal made in Canada at present is for fuel purposes only and is either forest-burnt or oven-burnt. Canadian producers seem to have demands for their full output in the winter, but are willing to supply this country in the

summer months. To follow such a course would be useless, as British importers wish to receive charcoal regularly throughout the year. Although retort-burnt charcoal is preferred, importers would be willing to experiment with present forest- or oven-burnt charcoal with orders for 25 tons, provided the cost is not over £12 per ton c.i.f. Liverpool. Firms in Liverpool specialising in charcoal are prepared to place orders with reliable producers in Canada immediately they receive satisfactory grade samples. Indeed they have already received from Canada samples of oven-burnt charcoal which proved of good quality; but, although orders were given, no Canadian shipments have yet arrived. It is assumed that the firms which submitted samples were unable to execute their orders for lack of supplies, shipping space, etc. If Canadian firms can supply and will develop a grade of charcoal equal to that from the Continent, they should be able to hold the British market indefinitely, especially as there is an import duty of 10 per cent. on all foreign charcoal, and none on that from Canada.

The British Starch Industry

The Present Position and Possible Development

by JAMES M. FAULDS

THE development of the starch industry is a story as old as humanity itself, and is constantly undergoing changes with the passage of the years. It is a far cry from the "mealies" made by the Indian inhabitants of the Americas, and the African natives, to the present gigantic structure centring round the world's crops of maize and wheat. Everyone is familiar with the surplus quantities of wheat and wheat flour available for export in Australia, Canada and other countries. Similar quantities, in excess of local requirements, occur among other crops which are suitable for starch extraction. The chief of these are maize, potato, tapioca, sago, manioc and rice.

It is natural to find the manufacture of starch carried out and fostered in the respective areas of cultivation, if industrial facilities are available, as these crops often constitute a considerable proportion of a country's natural resources. Thus the manufacture of farina from potatoes was one of Holland's basic industries, and, as such, was heavily subsidised so that the exported product could compete with other starches such as maize, sago and tapioca. For the same reason the internal industrial applications of farina were thoroughly investigated and, as alternative materials had to carry a heavy import duty, or even were completely prohibited, it is not surprising that considerable development took place. In this country, where all starch and the materials for its extraction are imported, it has been possible to select and develop the best product for each individual application.

There is a very large industry in this country handling starch. It comprises the manufacture of maize, rice and wheat starches from the respective imported raw materials, the manufacture of starch derivatives, such as dextrine, adhesives, glucose and dextrose, and the importing and distributing of all classes of starch made in various parts of the world. The imports of Dutch farina did not amount to much over 10 per cent. of the total starch imports, excluding the amount of starch made in this country. As practically all these sources are still available to us, the loss of the Dutch imports is not so serious as might at first appear. Furthermore it is expected that the demand for starch will automatically be curtailed by the restricted allocations of primary raw materials to the cotton and paper trades.

It is true that individual starches possess characteristic properties which may vary within considerable limits. These differences are further exhibited in their derived products, especially dextrine. Wherever it has been found imperative

to use potato starch, steps have already been taken to ensure that, when the present considerable stocks are finished, adequate supplies of absolutely satisfactory alternatives will be available. To this end the dextrine manufacturers have developed types of products possessing identical, if not superior properties for vital applications. It can be pointed out that glucose manufacture, which is an old-established industry in this country, has hitherto been mostly carried out from maize on a very competitive basis with continental supplies derived from farina.

It will thus be seen that the industries engaged on the production of starch and its derivatives are able to take advantage of the world's crops, and are not normally affected by poor harvests in any particular country. The existence of a surplus of potatoes in this country has been well known to the various sections of the starch and feeding-stuffs industries. Its disposal has already formed the subject of many researches and discussions. The reader's attention is directed to an article appearing in a recent issue of *The Farmer's Weekly*, from which it is clear that apart from the production of dried potato meal for cattle food, the manufacture of starch and its derivatives constitutes the logical economic development. The former is already practised in this country with considerable success. It is dependent, as starch manufacture would be, on the price of the potatoes available. On the price basis the manufacture of alcohol has already been ruled out as impracticable. In Germany, where it is largely carried out, two special conditions exist: (a) It has been imperative to aim at a policy of self-sufficiency for war purposes; and (b) the necessary surplus of potatoes has been assiduously developed and breeds have been cultivated which have a specially high content of suitable starch.

From the foregoing it is hoped that the reader will appreciate the considerations that have confronted the industrial specialists who have given this matter their earnest consideration in the past. Could some scheme be formulated, on the lines of the sugar beet industry, in conjunction with a long-term agricultural policy, we have men of comprehensive knowledge and experience in this country to put it into immediate operation. Past failures in this direction, and the heavy initial expenditure, make mature consideration essential. If a war-time measure should be adopted, the writer considers that it should be continued in post-war days to add another

(Continued at foot of page 345.)

FLOTATION CONCENTRATION OF OXIDISED MINERALS AND SALTS

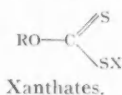
The Use of Collectors and Frothers

by D. D. HOWAT, B.Sc., A.I.C., A.Inst.M.M., Ph.D.

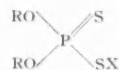
TO effect preferential concentration of metallic minerals in an ore and ensure rejection of worthless non-metallics use has been made of the differing specific gravities of the two classes of substances. This forms the basis of gravity concentration and was the only method available for many years. The washing of gold ores in pans, as practised from remote ages by primitive man, is a good example of the method, while the introduction at a later date of buddles, vanners, jigs, and tables merely extended the use of the same principle. The method had an obvious limitation—the narrower the gap between the specific gravities of the different minerals, the more difficult and less efficient did the separation become. At Broken Hill, N.S.W., during the first decade of the present century the complex lead-zinc-silver compounds, associated with a gangue containing heavy silicate minerals, afforded a most difficult problem. The necessity for treating lower-grade ores and the increased fineness of grinding necessary to liberate the valuable minerals were other factors that made it more and more essential to provide an alternative method of concentration. From the pioneer work by Elnore and later developments by Sulman and others there grew up fairly rapidly the completely new method of flotation concentration. The principle of the method involved the formation of a film of insoluble oil on the surface of the sulphide particles. Violent agitation of the ore pulp, after the addition of the necessary frothing reagents, produce a froth in which the oiled sulphide particles were collected. Extensive investigations on the properties of surfaces by Harkins, Adam, Langmuir and Rideal produced results which were capable of a direct application to the process of flotation. The reasons underlying the formation of a froth and the methods of producing relatively stable air-bubbles in a liquid pulp were widely known, but the most important advances were made by the gradual accumulation of knowledge of the composition and structure of organic compounds, the recognition of the differential properties induced in substances by the presence of a "polar group," and the understanding of the factors which governed the adsorption of soluble reagents on the surfaces of solids.

Reagents with Sulphur Groups

In a comparatively short time the insoluble oils formerly used to film the sulphide particles were replaced by soluble organic compounds containing various sulphur groups. The two most commonly used reagents of this type are the xanthates and the dithiophosphates which can be represented by the following structural formulae:—



Xanthates.



Dithiophosphates.

in which R is an organic radical and X is hydrogen or a metal. The "polar group" -S.SX in these compounds forms the means by which they are anchored to the surfaces of the sulphide particles. For some years all efforts of metallurgists carrying on research in flotation were directed towards developing more effective and more selective reagents for the treatment of sulphide minerals, and this art has now been brought to a high pitch of efficiency. Many complex ores, containing three different sulphide minerals, can be treated so as to produce a marketable concentrate of each.

The application of this knowledge of the flotation of sulphide minerals to the treatment of non-metallic minerals has

not been very extensive, largely because the cost of treatment was regarded as an almost insuperable barrier. The cost of these minerals, varying from a few shillings up to about £3 per ton, did not leave any great margin for concentration treatment. So only high-grade natural deposits suitable for direct mining and sale were worked. Another factor was that the mining and marketing of such minerals was a field for small untrained operators with very little capital available for expensive plant or equipment. So that in working minerals like phosphates, cement rock, fluorite and talc losses and wastage were of frequent occurrence. Evidence that the application of flotation to the non-metallic minerals might yield quite good results was furnished by the behaviour of sulphur, graphite and talc, all of which might be classified as "natural floaters." Cassiterite, fluorite, barite and mica are also capable of being floated relatively easily. Disregarding the treatment of coal-fines by froth flotation, a process dating back for over 20 years, it can be said that the first important step in the development of flotation concentration of oxidised minerals was its application to phosphate ores. This has been followed, within the past three years or so, by the treatment of cement rock, limestone, manganese and iron ores, fluorite and, very recently, by processes aimed at separating the chlorides of sodium and potassium in deposits where these minerals occur together.

Contact Angles

Each mineral, when placed at the interface of air and water, exhibits its own natural "contact angle," a small value of the contact angle involving easy spreading of the water over the surface of the mineral, and a large value a greater attraction between the mineral and air. Even if the dispersion of a cloud of relatively stable air-bubbles is effected in a pulp there are relatively few minerals which will float to the surface and concentrate in the froth without the addition to the pulp of some substance which is preferentially adsorbed at the surface of the desired mineral, producing on the particles a film with a much higher value of the contact angle. It has been fairly conclusively proved that adsorption is due to the presence of a "polar group" in the reagent and the formation of an insoluble compound on the mineral surface. Flotation of some of the more basic oxidised minerals could be relatively easily effected by oleic acid or its sodium salts. The carboxyl group of the acid serves to anchor the collector to the surface of the mineral forming an insoluble soap-film, while the long carbon chain, oriented at right angles to the surface, forms the film of high-contact angle. Oleates, stearates and palmitates, all of which have been extensively used, are classed as "anionic reagents."

The flotation of phosphates in an ore containing silica sand and clay as gangue has been described (J. A. Barr, Ind. Eng. Chem., 1934, 26, p. 811). Large plants with a total capacity of well over 10,000 tons of ore per day are in operation at Mulberry, Florida, and in Tennessee. Working in a pulp of pH value 8.5-9.2, the phosphate is floated, using oleic acid as a collector, direct operating cost of the concentration being only 13 to 16 cents per ton of feed. The oleic acid reacts with the tri-calcium phosphate forming an insoluble soap film around the particles. Two rather interesting points have been indicated by this work. First, the chemical aspect of adsorption has been shown by the fact that oleic acid is a more effective collector than a prepared soap solution, so that evidently a more complete filming action obtains when the insoluble soap film is formed on the surface

of the particles by the direct interaction of oleic acid and calcium phosphate. Second, the soap film could be made more cheaply and rendered more water-repellent if some of the oleic acid was replaced by a hydrocarbon, such as fuel oil, the most probable explanation of this being that the fuel oil formed an additional film on top of the soap film, a longer carbon chain resulting from the combination of the two existing chains.

Another interesting modification of the principle of coating phosphate particles with a water-repellent film is found in the work of Chapman and Littleford (U.S. Pat. No. 1,968,008). A mixture of oleic acid and fuel oil is added to the alkaline pulp, which is agitated as for flotation. The phosphate particles, now coated with a soap-film, are agglomerated by the fuel oil, the agglomerated particles being separated from the gangue and concentrated by the action of a transverse water-current on a vibrating table of the ordinary Wilfley type. From an ore with 21 per cent., a concentrate of 70 per cent. phosphate can be produced, the total recovery being 97 per cent.

Cement Rock Treatment

In recent years flotation of calcite from cement rock has come into wide use, and commercial plants employing flotation for the treatment of cement rock are operating successfully in several parts of the world. The function of flotation treatment is to render suitable for cement manufacture a rock which in the natural state does not have the desired proportions of calcite, silica, alumina, iron and magnesia. The method of treatment will vary according to the composition of the rock. One interesting system has been patented by Breerwood (U.S. Pat. No. 2,028,313). Preferential fine-grinding of the ore effects a considerable degree of concentration, a high percentage of calcite being found in the minus-325 mesh material, while the greater part of the silica and alumina is found associated with some calcite in the plus-325 mesh portion. Only this latter material need be treated by flotation, the necessary concentration of the calcite being effected in an alkaline pulp by the use of oleic acid as a collector and cresylic acid as a frother. Blending of the minus-325 pulp with the flotation concentrate is adjusted to give a mixture with 75.8 per cent. calcite, the standard for Portland cement mixture.

An example of the application of flotation to the treatment of oxidised metallic minerals is found in the work of Leaver and Royer on the treatment of slimes for the flotation of scheelite (U.S. Bur. of Mines, Tech. Publ. No. 585, 1938). Following upon this work a 75-ton-per-day flotation plant was put into commission at Mill City, Nevada, for the recovery of scheelite from slime material. Oleic acid as collector, along with a mixture of two patented frothing reagents, was used in the flotation cells. The best results were obtained by careful control of the pH value of the pulp, 9.0-9.5 being the only suitable range. Good recoveries of scheelite have been obtained from pulps with less than 0.4 per cent., the concentrates, averaging 6 to 20 per cent., being further concentrated, on Deister slime tables, to 50-65 per cent.

Fluorite ores have also been treated by the same process. This mineral is very easily floated and is quickly separated from silica, but the separation from calcite is a much more difficult problem. It was found by Clemmer and O'Meara (U.S. Bur. of Mines, Rept. Inv. No. 3239) that the calcite could be depressed by the use of sodium silicate, sodium bichromate, or copper or manganese sulphates, while using oleic acid to collect the fluorite. Two grades of fluorite are marketed, 85 per cent. mineral, used as "spar" in open-hearth steel furnaces, and 95 per cent. mineral, used for acid manufacture. Several flotation plants capable of yielding such products have been put into commission in the Kentucky-Illinois-Indiana district of the U.S.A. and in Kalan-guev in Russia.

Large tonnages of talc are absorbed in the production of cosmetics, lacquers, varnishes, textiles, etc., while one of

the most recent uses, which promises to absorb large quantities, is in ceramic for bodies that will mature at lower temperatures and resist "delayed crazing" of glazes. With increasing demands for the mineral, froth flotation has been extensively applied to the ores, the flotation section usually acting as a scavenger unit, treating the rejects of the dry-mill section. The Eastern Magnesia Talc Co., at Johnson, Vermont, U.S.A., mines a talc-magnesite ore containing small quantities of copper-nickel sulphides. A percentage of the talc is extracted from the finely-ground ore by air-separators, while the scavenge flotation unit recovers the balance from the residual ore. The mineral floats so easily that a simple frother like pine-oil is the only reagent required. Magnesite, of good refractory grade, and nickel-copper sulphides are recovered from the flotation tailing. In other places some work on talc flotation has necessitated the use of the complex substituted amine type of reagents.

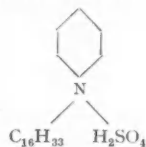
A novel adaptation of froth-flotation has been found in the separation of sodium chloride and potassium chloride from each other when suspended in a saturated brine made up from the crude mixed salts as they occur in nature. Such a separation of crystallised salts saves a great deal of refining and fractional crystallisation. Scores of separations of crystalline materials may be facilitated in this way. The process may at least assist in preparing a crude product carrying only small amounts of the undesired substances and capable at a single recrystallisation of giving the desired material in a high state of purity. The process in most common use for this purpose is the Weineig separation which is essentially a soap flotation involving oleic acid and oleates and aims at floating the sodium chloride away from the potassium chloride. The process is used at Carlsbad, New Mexico, by The Potash Company of America. Similar processes have been described by Russian workers. Kuzin (Flotation of Solykamsk Sylvinites Ores, Kalii, U.S.S.R., 1937, No. 1, p. 17) describes how sodium chloride can be floated away from the potassium chloride in the treatment of the Solykamsk ores by the use of enanthic acid, linoleic acid or ricinoleic acid in the proportions of 0.25 kg. to 1.5 kg. per ton of ore together with similar quantities of lead nitrate and sodium silicate, the separation being effected in a pulp with pH value less than 7. The same worker has also published laboratory results on the separation of borax or boric acid from sodium chloride.

These are only some of the numerous instances in which froth-flotation of oxidised minerals and salts is practised on a commercial scale. The field is large and further extensive developments are certain.

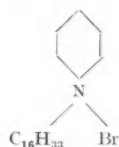
Substituted Amine Reagents

Recently a far-reaching advance has been made in this subject by the development of long-chain "cationic" reagents, many of which are of the substituted amine type. These have been described mainly in the patent literature and little information is available as to their practical application. Their use, however, would appear to open up very important lines of development. The first types of reagents investigated and patented were quaternary ammonium salts. The applicability of these salts is said to be due to their property of forming in aqueous solutions positively charged surface-active ions, in contradistinction to practically all hitherto known surface-active agents which form negatively charged ions. There are two British patents covering reagents of this type, the first, No. 410,956, granted to H. Th. Böhme A/G. for quaternary ammonium sulphate reagents, reference being made to the flotation of quartz by means of cetyl pyridinium sulphate. British Pat. No. 463,261, granted to E. I. Du Pont de Nemours and Co., covers the manufacture and use of quaternary ammonium or phosphonium or ternary sulphonium salts (other than quaternary ammonium sulphates). Mention is made of the use of trimethyl cetyl ammonium bromide and cetyl pyridinium bromide, the latter being used to float feldspar. There is very slight difference

between the two types of compounds as shown by the following structural formulae:—



Cetyl pyridinium sulphate.



Cetyl pyridinium bromide.

Trimethyl cetyl pyridinium bromide has been investigated by Wark (J. Phys. Chem., May, 1936) who has shown that the compound is adsorbed from aqueous solutions by a wide variety of minerals and, since it possesses the polar/non-polar structure characteristic of collectors, it is almost a universal flotation reagent of the collector class. Wark points out that these substituted ammonium salts and amines containing a large non-polar group may prove of great value in the flotation of silicates and oxides. They have one great advantage over the oleates, stearates, etc., in that they do not form insoluble salts with such cations as calcium, copper, iron, etc., so that low concentrations will suffice and there is no waste due to precipitation. On the other hand, the reagent causes the flotation of so many minerals that its successful use will depend on the choice of suitable conditions and depressant reagents which are differential in action. For example, in an alkaline solution galena is depressed while sphalerite floats. In an acid solution quartz can be floated away from cassiterite. Strangely enough calcite does not seem to be floated by this reagent.

Among some of the claims made for these "cationic" reagents are the flotation of quartz and feldspar and the separation of sodium and potassium chlorides. Quite an extensive modification of some of the flotation procedures mentioned may be made if the claim to float quartz easily can be substantiated. For example at one of the large cement-rock plants at Valley Forge, near Philadelphia, reagents are used which must float 70 per cent. of the ore away from the remaining 30 per cent., which is highly siliceous. If one of these recently developed cationic reagents were to be substituted and the siliceous minerals filmed and floated, the capacity of the flotation cells would be increased by about one-half and a cleaner separation might be expected.

One patent (U.S. Pat. No. 2,074,699) claims that very high recoveries of sillimanite from Travancore sands can be effected by the use of a compound like heptadecylamine hydrochloride.

Salt Separation

It appears that one of the most important fields for the use of these new reagents lies in the difficult and tricky salt separations. The U.S. Bureau of Mines evolved a separation of sodium chloride and potassium chloride by means of sodium octadecyl sulphate which acts both as collector and frother, lifting the potassium chloride in a pinkish froth.

J. E. Kirby, of E. I. Du Pont de Nemours and Co. (U.S. Pat. No. 2,088,325), gives results obtained in the flotation of potassium chloride from sodium chloride in sylvinitic ores from Carlsbad, New Mexico. Working on ore samples containing 40 per cent. potassium chloride and 57 per cent. sodium chloride, he obtained a 79 per cent. concentrate, in which 99.3 per cent. of the total potassium chloride was recovered, by the use of 0.39 lb. per ton of *n*-octylamine hydrochloride as a collector.

De Vaney and Cooke (U.S. Bur. of Mines Rept. Inv. No. 3300, 1936) have worked out a method for the separation of langbeinite (a double sulphate of potassium and magnesium) from sodium chloride for application to such ores from the potash field of New Mexico and Texas. The langbeinite was concentrated to 95.5 per cent. in the froth by the use of sodium octadecyl sulphate.

It will be evident from the results quoted that there is at least every possibility that a completely new tool has been placed in the hand of the chemical engineer. By the develop-

ment of suitable organic reagents and proper control of flotation conditions it may be easily possible in the future to dispense with some of the interminable and involved fractional crystallisations which have hitherto been the only available methods of separating valuable chemical salts from their ores and associated minerals.

Sodium Phosphates as Inhibitors

Precipitation of CaCO₃ Suppressed

THE extent and nature of the action of sodium meta-, pyro-, and ortho-phosphates in inhibiting the precipitation of calcium carbonate from ammoniacal solution has been studied by Reitemeier and Buehrer (J. Phys. Chem., 1940, 44, 5, 535-574).

The investigation covered the effect of sodium hexametaphosphate (glassy), crystalline metaphosphate, pyrophosphate, and orthophosphate (tribasic) in inhibiting the precipitation of CaCO₃ from solutions containing 200 p.p.m. of CaHCO₃ and 550 p.p.m. of NH₄OH. Not only the amount of precipitate formed, but also its microscopic appearance and its X-ray spectrograph were investigated. It was established that glassy hexametaphosphate and pyrophosphate are about equally effective in suppressing the precipitation of CaCO₃, which is complete at about 1 p.p.m. of the reagents. Crystalline metaphosphate has very little effect by itself, but in the presence of KOH it is as efficient as the other two salts; the efficiency of the orthophosphate is always low, being circumscribed by the precipitation of calcium phosphate. No other inorganic salt has a similar inhibitive property, which therefore appears to be highly specific for the molecularly dehydrated phosphates alone.

The threshold concentration of the hexametaphosphate required to prevent the precipitation of calcium completely under the above conditions increases with increase in the NH₄OH concentration and (much more rapidly) with increase in the calcium concentration. The efficiency of the inhibition is increased by ammonium and neutral sodium salts.

Ultramicroscopic studies of the solutions show that no colloid phase is formed. The crystals of carbonate formed (when inhibition is incomplete) are of calcite, and are much larger than would be formed in the absence of a phosphate; they are also extremely distorted, and contain an amount of phosphate such that the Ca/P ratio in them is c. 300, when the concentration of reagent is greater than 0.6 p.p.m. It is concluded that the inhibitory action is due to this adsorption on crystal faces.

(Continued from page 342.)

industry to our country. Each starch, in the writer's opinion, has an intrinsic value related to its cost of production, discounting entirely the aspect of foreign trade. Thus farina would normally cost from £16 to £17 a ton to produce, a figure far in excess of the prices at which past sales have been made. There is no reason why production in this country should not compete with continental supplies provided that the necessary agricultural policy can be adopted.

For the present any farina produced in this country would probably be held for admixture with wheat flour for baking purposes. This is a practice followed in Holland, and with other starches in their respective countries of production. These additions can be regarded as bread improvers, rather than as diluents, provided the farina be suitably modified. The disposal of any further quantity would be effected through the various efficient controls which have been in operation since the beginning of the war. Should such a scheme come to fruition, the chemical trade can be assured that a further extension of the helpful co-operation, already existing in the various branches of starch technology, will be extended to useful purpose. It is well to bear in mind that their assistance in the past has enabled this country to build starch, dextrine, and glucose plants which are, in every respect, the equal of their continental counterparts.

Personal Notes

DR. NEIL CAMPBELL, Lecturer in Chemistry at Edinburgh University, was married in Edinburgh on June 19 to Miss Marjory Stewart, also of Edinburgh.

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MR. JAMES ROSS, assistant works manager at the Dalzell Steel Works of Colville's, Ltd., has been appointed manager of the works in succession to Mr. D. G. Fraser.

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On the result of the examination for associate-membership of the Institution of Chemical Engineers the William Macnab Medal for 1940 has been awarded to Mr. J. V. S. GLASS.

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MR. ALLAN J. HOLDEN, B.Sc., F.I.C., has been appointed Secretary of the British Colour Makers' Association to replace Mr. J. Davidson Pratt, who, as already notified, has undertaken special duty as a Deputy Director General at the Ministry of Supply.

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LORD MELCHETT has left on an important mission to America, in which he hopes to stimulate the supply from the United States of those chemicals which are essential to Britain's war industry.

* * *

MR. DOUGLAS JEPSON, technical service and research metallurgist at I.C.I. (General Chemicals), Ltd., central laboratory, has been appointed Lecturer in Metallurgy at Bradford Technical College from next September, in succession to Mr. H. A. MacColl, who has resigned.

OBITUARY

MR. ROBERT BROWNLIE SOMERVILLE, of the firm of William Somerville and Son, oil refiners, Blantyre, Lanarkshire, died recently in Glasgow, aged 57.

Export Group Formed

Pest Control Chemicals

AT a recent meeting of interested firms, the Pest Control Chemicals Export Group was formally inaugurated. The Group has now received the recognition of the Export Council of the Board of Trade and 36 firms have already signified their intention of joining.

The chairman of the Group and of the general executive committee is Mr. H. M. Spackman (Jeyes Sanitary Compounds Co., Ltd.), and Mr. T. Ainslie Robertson (Plant Protection, Ltd.) is the vice-chairman. Other members of the executive committee are Mr. F. H. Hall (Agricultural Insecticides and Fungicides Sub-group), Mr. V. G. Hine (Animal Medicines and Allied Products Sub-group), Mr. D. S. A. McDougall (Disinfectant Sub-group), Mr. L. K. Osmond (Animal Medicine and Allied Products Sub-group), Mr. H. A. Smith and Mr. W. E. O. Walker-Leigh (Sheep and Cattle Dip Sub-group). A nominated representative of the Association of British Chemical Manufacturers will be an *ex-officio* member of the general executive committee.

CONSULAR REPORTS quoted by "World Trades Notes" reports a notice of the Reich Chemical Board effective from May 1, 1940, which restricts the purchase and sale of phosphoric fertilisers by the fertiliser trade in Germany for the year ended April 30, 1941, to 25 per cent. of their respective purchases and sales during the year ended April 30, 1939. The percentage is based on the P_2O_5 content of the fertiliser and sales are limited only to such customers as were applied in the year ended April 30, 1939. The official ratios of anhydrous phosphoric acid in German phosphoric fertilisers as published, are as follows: Basic slag, 16 per cent.; "Rhenanphosphate," 25 per cent.; "Nitrophoska," 12 per cent.; "Kamp" fertiliser, 12 per cent. For all other phosphoric fertilisers, the actual P_2O_5 contents will be calculated.

New Control Orders

Boron Preservatives in Margarine

THE Minister of Food has made the Margarine (Addition of Borax) Order, 1940, dated June 14 (S.R. and O., 1940, No. 982; H.M.S.O., 1d.). The Order permits margarine manufacturers to utilise borax (which in the Order is defined as including boric acid and borates) as a preservative, provided that a licence for the purpose has been secured by the manufacturer from the Ministry of Food. The provisions of the Order will not apply to margarine for export or for use as ships' stores.

Export of Cobalt

The Board of Trade has made the Export of Goods (Control) (No. 18) Order, 1940, under which, from June 25, the export of cobalt compounds is prohibited to all destinations instead of to certain destinations only as heretofore.

Synthetic Resin and Anemometers

Under the Export of Goods (Control) (No. 20) Order, 1940, which comes into force on July 4, licences will in future be required for the export to any destination of diethyl diphenyl urea and dimethyl diphenyl urea (centralites and carbamites), and of cellulose acetate and transparent synthetic resin in the form of blocks, rods, sheets or strips, machined, pressed, turned, polished or otherwise prepared, of 2 mm. or more in thickness or diameter. Licences will not be required for the export of all flowmeters not containing mercury, but will be required for the air speed indicators and anemometers, Dines pressure tube type.

Impermeability of Papers

Continuous Surface Film Essential

A CLASSIFICATION of paper materials according to their permeability by water vapour has been made by Babbitt (Can. Jour. Res., 1940, 18, 5, 90-98). The use of some form of impermeable covering on the interior face of exterior walls is now compulsory in Canada, such a covering being especially important in preventing condensation in buildings which have conditioned air systems.

A large number of papers were examined for permeability by water vapour, and it was found that sheathing papers, whether dry or saturated with asphalt or tar, are no barrier to the diffusion of water vapour, nor are asphalt-saturated rag or asbestos felts. Three types of paper which do provide good resistance to the passage of water vapour are:

(1) Kraft papers, asphalt-saturated and coated, or merely coated (not saturated) or "infused" with a coating of asphalt on one side only, most of the asphalt remaining in the surface, little penetration occurring.

(2) Light waxed papers, i.e., those in which the waxing is mainly on the surface. The heavy waxed papers, in which considerable penetration has occurred, are not so efficient.

(3) Heavy roofing papers (as is indeed to be expected).

The most important feature for impermeability of a paper is evidently that the impregnant should be present as a continuous film in the surface. Mere filling up of the pores in the paper is not sufficient and is therefore a waste of the impregnating material. The most satisfactory material investigated from the point of view of weight and cost is the light waxed paper. It was concluded that for complete protection, the paper must reduce the permeation of water vapour to 0.5 gm/24 hrs./sq. meter/mm. mercury.

A NEW SOURCE OF METHANE in Italy has been located at Capanne Bruciate, in the province of Pisa. A first drill discovered methane at a depth of 32 metres, and this is now giving 300 cubic metres a day at a pressure of three atmospheres. Further drills in the neighbourhood have also proved successful. It is claimed that analysis of the gas carried out at the University of Pisa shows it to be the purest so far discovered in Italy. It has been decided to erect a large compressor station in the district.

Anhydrous Aluminium Bromide

Simple Preparation of a Valuable Catalyst

A SIMPLE and convenient method for preparing anhydrous aluminium bromide is described in *Industrial and Engineering Chemistry* (1940; 32, 6, 856-7) by P. K. Winter and P. L. Cramer, of General Motors Corporation, Detroit, Michigan. Extracts from their report are printed herewith.

Among the advantages possessed by aluminium bromide over aluminium chloride as a catalyst in certain organic reactions are its greater solubility in hydrocarbons, resulting in a homogeneous reaction mass, and its higher catalytic activity. In addition, the bromide may be readily purified by simple distillation whereas the chloride sublimes. The increasing use of anhydrous aluminium bromide has created a need for a simple and convenient method of preparing it. The object of the present proposed method is to provide a reasonably pure product in any desired quantity, in one operation, with a relatively high rate of production, and with a minimum of operating difficulties.

The apparatus is shown in the diagram. The bromine is introduced near the bottom of the reaction flask where it comes into contact with the aluminium chips or pellets. The flask may be warmed gently at first to start the reaction, but in a short time the reaction supplies enough heat to vaporise the incoming bromine and to distil the aluminium bromide out through the side arm on the neck of the flask, where it condenses and flows into the auxiliary purifier. The molten aluminium bromide refluxes down through the mass of aluminium chips in the flask, and serves to prevent local overheating and consequent fusion of the metal. The bottom of the flask is protected against occasional molten globules of aluminium by a layer of glass wool. The bromine tube must not be joined to the flask by a permanent glass seal, because it must be removed and cleaned occasionally when the lower end becomes clogged with solid impurities coming from the technical grades of bromine and aluminium. The loose joint shown may be sealed satisfactorily by an easily broken cement of pumice, water-glass, and water. The level of this joint should be above that of the exit tube to avoid having the bromide reflux over it. The mouth of the flask is closed by a loosely fitting glass stopper.

As the reaction proceeds, aluminium is consumed largely from the centre of the flask, and the bromine ultimately channels up through it and is carried over with the aluminium bromide. When this occurs, the bromine supply is shut off, the stopper is removed, a hole is punched through to the interior of the mass of aluminium chips by means of a heavy glass rod, and the flask is refilled with aluminium chips.

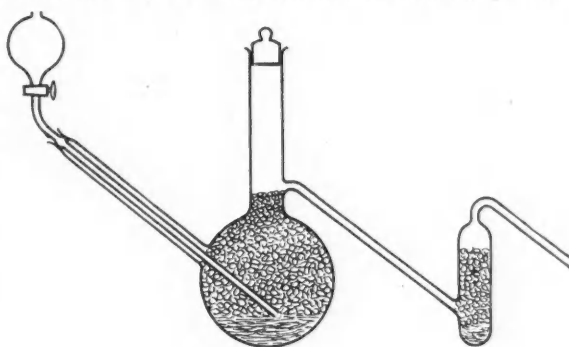
Collection and Storage

The initial product as it distils from the reaction flask is usually nearly water-white, and may be collected in a reaction vessel for immediate use or in a flask for storage. Sometimes, however, it is contaminated by a little free bromine and by impurities carried over mechanically. For this reason it is best to run it directly from the reaction flask to the bottom of a small distilling vessel filled with aluminium chips. Auxiliary heating is required to distil the aluminium bromide out of the purifier. A clean water-white product is thus obtained in a continuous process. For convenience in storing and subsequent use, the best receiving vessel is a distillation flask, whose neck and side arm are constricted for convenience in sealing after it is filled.

Before the reaction is started, the whole system should be flushed out with a dry gas (air or nitrogen) in order to avoid hydrolysis of the bromide. The side arm of the receiver should be provided with a guard to prevent the entrance of moisture. When the flask is about three-quarters full, the reaction is stopped, and both the neck and the side arm are sealed. The aluminium bromide thus collected can be tored

indefinitely without deterioration. Without further purification, aluminium bromide thus produced melted at 97.2° and boiled at 254° C. (760 mm. pressure).

The size of the apparatus is governed by the production rate desired. A one-litre reaction flask can easily produce a



kilogram or more of aluminium bromide per hour. The rate of production is controlled by the flow of bromine, and is limited by the condensing capacity of the receiver and by the maximum safe temperature within the reaction flask, which is just under the melting point of the aluminium. The apparatus described has ample capacity to supply aluminium bromide for laboratory uses, and there is no apparent reason why the principles involved might not be employed on a much larger scale.

Arsenic Salts for Preserving Wood

A Swedish Method

THE Boliden Mining Company, which operates copper and gold mines in Sweden, has accumulated an enormous stock of arsenic for which it can find no market, and which, because of its poisonous nature, has been stored at considerable expense. In an effort to expand the market for arsenic, research has been conducted in the field of wood impregnation and it is alleged that an effective and economical salt has been developed and tested over a period of years. The following brief description appeared in *Swedish Export* (April 1940), and is quoted by the U.S. Department of Commerce in *World Trade Notes*.

The impregnation liquid used consists of a solution of various salts, including those of arsenic, and after these salts have entered the timber a chemical process takes place, with the co-operation of certain easily oxidised substances in the wood itself. The final result of this process is the production of zinc arsenate and chromic arsenate, which become fixed in the wood, and constitute the effective elements against the attacks of decay or insects. Arsenic-impregnated timber is stated to retain its mechanical qualities. It takes on a weak green colour with a slight brown shade, which is strong enough to render painting unnecessary if the timber is used in buildings. Another advantage is that the timber does not catch fire as easily and burns less quickly than when unimpregnated.

Costs of the new method compare favourably with other methods used and it can be applied in small establishments. In the Scandinavian countries, arsenic-impregnated timber is being increasingly used for various outdoor purposes, including quay and other under-water constructions. About a dozen impregnation works in various parts of Sweden and others in Norway and Finland are employing the method.

General News

THE INSTITUTION OF CHEMICAL ENGINEERS announces that the following candidates were successful in the Associate-Membership Examination for 1940:—K. F. Bray, J. Dijkstra, J. V. S. Glass, H. Heron, D. J. N. Hoffman, R. H. Keach, W. J. King.

THE BAKERIAN LECTURE of the Royal Society was delivered on Thursday afternoon last at Burlington House, by Professor N. V. Sidgwick and Mr. H. M. Powell. Their subject was "Stereochemical Types and Valency Groups."

MESSRS. WALWORTH, LIMITED, in their announcement on page ix, point out that owing to the tightening up of control on all production and supplies, buyers should, in their own interests, specify Government Department symbols and Contract Numbers on all orders entitled to them. This will expedite delivery of all orders placed for work of national importance.

SUCCESSFUL RESULTS HAVE BEEN OBTAINED from a Salvage Flying Squad, composed of specially adapted railway vans, which is touring 100 L.M.S. stations in the London area to collect salvage. Already, by this and other means, nearly 400 tons of scrap metal, waste paper, old rope, straw, timber, etc., found mostly in small quantities, has been collected.

ACCORDING TO THE Board of Trade returns for the month ended May 31, 1940, imports of chemicals, drugs, dyes and colours into the United Kingdom were valued at £1,906,674, an increase of £213,080 compared with figures for the corresponding period last year. Exports were valued at £3,077,219, an increase of £692,779. Re-exports were valued at £90,935.

FROM JULY 1 ALL BRANCHES OF Monsanto Chemicals, Ltd., will be controlled direct from the factory at Ruabon, and from this date all communications should be addressed to Monsanto Chemicals, Ltd., Ruabon, Wrexham, Denbighshire (Tel. Ruabon 3191). A small staff in constant communication with Ruabon factory will be retained at the London office.

PART OF THE UPPER FLOOR of a grain store in Glasgow, belonging to Scottish Agricultural Industries, Ltd., collapsed last Monday. The premises were packed with feeding stuffs, and bags of oil-cake and meal, mixed with stones and lime, fell to the ground. A storeman, James O'Reilly, had a narrow escape. His fall was broken by bags of oil-cake, and he only had slight injuries. The collapse was confined to the top floor, the roof and other floors holding.

DR. J. F. TOCHER, at a meeting of the governing body of the North of Scotland College of Agriculture at Aberdeen last week, asked and received approval of trials to find out the possibilities of potato shaws (haulms) for paper making. Dr. Tocher said that 30 per cent. of the paper made in Germany was made from potato shaws. Further details of the potato products industry will be found in the recent issue of THE CHEMICAL AGE (1940, 42, 1089-1092).

AN ENTIRELY NEW and authoritative work of reference, presenting a detailed cross-section of the present-day language of science and technology, is announced by W. and R. Chambers, Ltd., of Edinburgh. This is *Chambers's Technical Dictionary*, which contains 968 pages with 50,000 entries covering every branch of scientific and technological terminology. The general editor is Mr. C. F. Tweney; the chemical section is supervised by Dr. C. J. W. Hooper and Dr. R. G. Israel, the metallurgical section by Dr. J. M. Robertson. The price of this comprehensive work is 15s.

Foreign News

CANADA'S APRIL IMPORTS OF ALUMINA, including bauxite, amounted to 107,279 cwt., valued at \$83,932 in comparison with 53,196 worth \$52,742 in April, 1939, the Dominion Bureau of Statistics reports. Most of this came from the United States.

PRODUCTION OF GYPSUM in February in Canada amounted to 50,689 tons, against 64,252 tons in January and only 5331 tons in February, 1939. For the first two months, production totalled 120,941 tons (23,794 tons in Jan.-Feb., 1939).

REPORTS FROM CHUNGKING, according to Reuter, forecast a huge increase in the production of mercury, planned by the Chinese Government. From a peak figure of 300 tons per annum in 1917-18, mercury production in China has dropped steadily since, and in 1938 China had to import mercury for newly-established chemical works.

From Week to Week

LAST MARCH the local Press stated that bauxite deposits had been discovered on the eastern part of St. Lucia, B.W. Indies. It is not yet known whether the material exists in commercial quantities, but samples have been sent to the United States and England for analysis.

ADIPIC ACID is made on the industrial scale by oxidation of cyclohexanol. By-product formation of succinic acid is reduced and the yield of adipic acid improved by the process of U.S.P. 2,191,786, according to which the reaction is carried out in acid solution. Adipic acid has been used in the manufacture of plasticisers and resins and has more recently come into prominence as a raw material for nylon.

UNTIL RECENTLY, when bauxite was discovered in Brazil near the city of S. Paulo, all known deposits were distant from manufacturing centres and ports, and transport facilities were inadequate. If present analyses of the ore are found satisfactory, it is believed that the new deposits will suffice to supply local as well as export demands, according to a report in Mineral Trade Notes, U.S. Bureau of Mines.

EXPORTS OF CRUDE COPPER from Yugoslavia to Germany in the first quarter of 1940 were valued at 84 million dinar, against 17 million dinar during the same period of 1939; exports of various ores were valued at 35,400,000 dinar, against 16,300,000 dinar. Exports of crude copper to France during the same period were valued at 53 million dinar, against 8,100,000 dinar, and of various ores at 39,300,000 dinar against 4,800,000 dinar.

EXPORTS OF TOLUOL from the United States during the first quarter of 1940, reported by the Department of Commerce in "World Trade Notes," amounted to 12,601,654 lb. valued at \$743,340. The principal countries of shipment were: United Kingdom, 560,195 lb. (\$33,321); France, 1,811,712 lb. (\$94,943); Italy, 2,373,651 lb. (\$114,337); Norway, 573,881 lb. (\$38,629); Spain, 1,180,457 lb. (\$83,380); Sweden, 3,694,898 lb. (\$248,653); Canada, 571,145 lb. (\$24,052); Japan, 1,512,063 lb. (\$87,391).

EESTI FOSFORIT, of Tallinn, has decided to undertake the exploitation of the known phosphoric strata of the Cambrian formation in Estonia. These lie along the northern Baltic coast in a horizontal stratification, for the most part about 1.5 metres in thickness, and crop out in glint. The construction of a 1200-ton flotation plant has begun, and this will be in operation before the end of 1940. The plant has been supplied by the Düsseldorf works of the Gutehoffnungshütte Oberhausen A.G.

SYLVAN (OR 2-METHYL FURAN) is a furfural derivative which is of interest for its solvent properties and its value as an intermediate. The boiling points of some of its azeotropic mixtures have been determined by Przanisnikov and Genin. It forms constant boiling mixtures with methyl alcohol (b.p. 51.5° C.), with methyl alcohol and water (b.p. 51.2° C.), with water alone (b.p. 58.2° C.) and with a mixture of acetone and water (b.p. 55.6° C.). Sylvan itself boils at 64° C.—*J. Gen. Chem.* (U.S.S.R.; 1940, No. 1, p. 141).

THE FULL TEXT OF THE trade and currency agreement signed between Hungary and Yugoslavia on April 10 has now been published in the Yugoslavian official journal. The agreement provides for an annual import quota into Yugoslavia of 220,000 tons of iron ore, 40,000 tons of pyrites, 60,000 tons of basic slag, 800 tons of calcium carbide, 120 tons of methyl alcohol, 120 tons of ethyl alcohol, 100 tons of calcium acetate, 1200 tons of dye-stuffs, 150 tons of trichlorethyl, 250 tons of tetrachlorethane, 600 tons of ferro-manganese, 2000 tons of zinc, 1000 tons of zinc powder and 20,000 tons of pine logs and waste for cellulose production.

IT IS REPORTED from the office of the American Trade Commissioner in Batavia that the proposals relating to the establishment of a major chemical industry in the Netherlands Indies have been discussed and considered for some time by the Governments of the Netherlands and the Netherlands Indies. The Department of Economic Affairs of the Government of the Netherlands Indies has urged, in connection with the present situation, that a decision should be made as soon as possible, as the execution of the plan, if adopted, will occupy a considerable period. All departments of the Government of the Netherlands Indies concerned have advised in favour of the establishment of this major chemical industry.

Weekly Prices of British Chemical Products

A STEADY demand for industrial chemicals is reported this week and a slight improvement can be recorded in the volume of inquiry both for home and export. The majority of the soda products are firm in quotation and there is a good call for most items. Acetic, formic and oxalic acids are in good request, with the latter item continuing in short supply. There is a fair seasonal inquiry for tartaric and citric acids, and formaldehyde and sal ammoniac are moving well. Among the potash materials supplies of carbonate, caustic and yellow prussiate are insufficient to meet the immediate demand. Values throughout the market are steady and unchanged with the exception of borax and boric acid, which have been advanced by the makers by £2 10s. and £3 per ton respectively, the increase dating from June 24. In the market for coal tar products business has been on the quiet side with quotations generally unchanged at recent levels. Reports from dealers indicate a good export inquiry.

MANCHESTER.—The Manchester chemical market during the past week has been a little more settled after the uncertainty last week resulting from the developments in the European war situation. The undertone of the market in all directions is steady to firm, though actual changes compared with a week ago, have been of relatively little importance apart from the sharp rise in borax and boric acid. Sellers report that a moderate amount of fresh business has been transacted during the past few days, with good quanti-

ties being taken against old orders by most classes of users. There has been a generally active demand for light tar products, values of which are all very firm.

GLASGOW.—In the Scottish heavy chemical market, there has been quite a brisk demand during the past week, and the booking of a fair amount of orders has resulted in prices being well maintained with an upward tendency. This looks as if it would continue so long as the Government speeding-up of output is sustained.

Price Changes

Rises: Borax, Commercial; Boric Acid; Sodium Phosphate, Tri-sodium; Tartaric Acid; Wood Naphtha.

* In the case of certain products, here marked with an asterisk, the market is nominal, and the last ascertainable prices have been scheduled. At present all intermediates are included under this head.

General Chemicals

Acetic Acid.—Maximum prices per ton: 80% technical, 1 ton £36 10s.; 10 cwt./1 ton, £37 10s.; 4/10 cwt., £38 10s.; 80% pure, 1 ton, £38 10s.; 10 cwt./1 ton, £39 10s.; 4/10 cwt., £40 10s.; commercial glacial, 1 ton, £46; 10 cwt./1 ton, £47; 4/10 cwt., £48; delivered buyers' premises in returnable barrels. £4 per ton extra if packed and delivered in glass.

Acetone.—Maximum prices per ton, 50 tons and over, £52 10s.; 10/50 tons, £53; 5/10 tons, £53 10s.; 1/5 tons, £54; single drums, £55, delivered buyers' premises in returnable drums or other containers having a capacity of not less than 45 gallons each; delivered in containers of less than 45 gallons but not less than 10 gallons £10 10s. per ton in excess of maximum prices; delivered in containers less than 10 gallons each £10 10s. per ton in excess of maximum prices, plus a reasonable allowance.

Alum.—Loose lump, £9 10s. per ton, d/d, nominal.

Aluminium Sulphate.—About £8 per ton f.o.b. Liverpool.

Ammonia Anhydrous.—99.95%, 1s. to 2s. per lb., according to quantity in loaned cylinders, carriage paid; less for important contracts.

Ammonium Carbonate.—£32-£36 per ton d/d in 5 cwt. casks.

Ammonium Chloride.—Grey galvanising, £18 per ton, in casks, ex wharf. See also Sal ammoniac.

***Antimony Oxide.**—£68 per ton.

Arsenic.—99/100%, about £25 per ton, ex store.

Barium Chloride.—98/100%, prime white crystals, £11 10s. 0d. to £13 per ton, bag packing, ex works; imported material would be dearer.

Bleaching Powder.—Spot, 35/37% £10 per ton in casks, special terms for contract.

Borax, Commercial.—Granulated, £23; crystals, £24; powdered, £24 10s.; extra fine powder, £25 10s.; B.P. crystals, £32; powdered, £32 10s.; extra fine, £33 10s. per ton for ton lots, in free 1 cwt. bags, carriage paid in Great Britain. Borax Glass, lump, £68; powder, £69 per ton in tin-lined cases for home trade only, packages free, carriage paid in Great Britain.

Boric Acid.—Commercial, granulated, £37 10s.; crystals, £38 10s.; powdered, £39 10s.; extra fine, £41 10s.; large flakes, £50; B.P. crystals, £46 10s.; powdered, £47 10s.; extra fine powdered, £49 10s. per ton for ton lots in free 1-cwt. bags, carriage paid in Great Britain.

Calcium Bisulphite.—£6 10s. to £7 10s. per ton f.o.r. London.

***Calcium Chloride.**—GLASGOW: 70/75% solid, £5 12s. 6d. per ton ex store.

Charcoal Lump.—£10 to £12 per ton, ex wharf. Granulated £11 to £14 per ton according to grade and locality.

***Chlorine, Liquid.**—£19 15s. per ton, d/d in 16/17 cwt. drums (3-drum lots); 4½d. per lb. d/d station in single 70-lb. cylinders.

Chrometan.—Crystals, 4d. per lb.; liquor, £19 10s. per ton d/d station in drums. GLASGOW: Crystals 4d. per lb. in original barrels.

Chromic Acid.—1s. per lb., less 2½%; d/d U.K. GLASGOW: 1s. 0½d. per lb. for 1 cwt. lots.

Citric Acid.—1s. 2d. per lb. MANCHESTER: 1s. 5d.

***Copper Sulphate.**—Nominal.

Cream of Tartar.—100%, £6 7s. per cwt., less 2½%, d/d in sellers' returnable casks; imported material would be dearer.

Formic Acid.—85%, £44 10s. per ton for ton lots, carriage paid, carboys returnable; smaller parcels quoted at 46s. 6d. to 49s. 6d. per cwt., ex store.

Glycerine.—Chemically pure, double distilled, 1,260 s.g., in tins, £3 10s. to £4 10s. per cwt. according to quantity; in drums, £3 2s. 6d. to £3 16s. 0d. Refined pale straw industrial, 5s. per cwt. less than chemically pure.

Hexamine.—Technical grade for commercial purposes, 1s. 4d. per lb.; free-running crystals are quoted at 1s. 7½d. to 1s. 10½d. per lb.; carriage paid for bulk lots.

Hydrochloric Acid.—Spot, 6s. 1½d. to 8s. 7½d. carboy d/d according to purity, strength and locality.

Iodine.—Resublimed B.P., 9s. 2d. to 13s. per lb., according to quantity.

Lactic Acid.—Dark tech., 50% by vol., £33 per ton; 50% by weight, £38; 80% by weight, £67; pale tech., 50% by vol., £39 10s.; 50% by weight, £46, 80% by weight, £74. Not less than one ton lots ex works; barrels returnable, carriage paid.

Lead Acetate.—White, £48 to £50, ton lots.

Lead Nitrate.—About £44 per ton d/d in casks.

Lead, Red.—English, 5/10 cwt. £42; 10 cwt. to 1 ton, £41 15s.; 1/2 tons, £41 10s.; 2/5 tons, £41; 5/20 tons, £40 10s.; 20/100 tons, £40; over 100 tons, £39 10s. per ton, less 2½ per cent. carriage paid; non-setting red lead 10s. per ton dearer in each case. Continental material £1 per ton cheaper.

Lead, White.—Dry English, less than 5 tons, £51 10s.; 5/15 tons, £47 10s.; 15/25 tons, £47; 25/50 tons, £46 10s.; 50/200 tons, £46 per ton less 5 per cent. carriage paid; Continental material £1 per ton cheaper; ground in oil, English, 1/5 cwt., £60; 5/10 cwt., £59; 10 cwt. to 1 ton, £53 10s.; 1/2 tons, £57; 2/5 tons, £56; 5/10 tons, £54; 10/15 tons, £53; 15/25 tons, £52 10s.; 25/50 tons, £52; 50/100 tons, £51 10s. per ton less 5 per cent. carriage paid. Continental material £2 per ton cheaper.

Litharge.—1 to 2 tons, £41 per ton.

Magnesite.—Calcined, in bags, ex works, about £12 to £15 per ton.

Magnesium Chloride.—Solid (ex wharf), £12 to £13 5s. per ton.

Magnesium Sulphate.—Commercial, £12 to £14 per ton, according to quality, ex works.

Mercury Products.—Controlled price for 1 cwt. quantities: Bichloride powder, 12s. 3d.; bichloride lump, 12s. 10d.; ammon. chloride powder, 14s. 2d.; ammon. chloride lump, 14s.; mercurous chloride, 14s. 7d.; mercury oxide, red cryst., B.P., 16s. 4d.; red levig. B.P., 15s. 10d.; yellow levig. B.P. 15s. 9d.

***Methylated Spirit.**—61 O.P. industrial, 1s. 5d. to 2s. per gal.; pyridinised industrial, 1s. 7d. to 2s. 2d.; mineralised, 2s. 6d. to 3s. Spirit 64 O.P. is 1d. more in all cases and the range of prices is according to quantities.

***Nitric Acid.**—Spot, £19 to £26 per ton, according to strength, quantity and destination.

Oxalic Acid.—From £60 per ton for ton lots, carriage paid, in 5-cwt. casks; smaller parcels would be dearer; deliveries slow.

***Paraffin Wax.**—Nominal.

Potash, Caustic.—Liquid, £30 to £35 per ton, according to quantity.

Potassium Bichromate.—Crystals and granular 6d. per lb.; ground, 7d. per lb., carriage paid.

Potassium Carbonate.—96/98%, quoted between £37 10s. and £40 per ton.

Potassium Chlorate.—Imported powder and crystals, ex store London, 10d. to 1s. per lb.

Potassium Iodide.—B.P., 8s. to 11s. 2d. per lb., according to quantity.

Potassium Nitrate.—Small granular crystals, £26 to £29 per ton ex store, according to quantity.

Potassium Permanganate.—B.P., 1s. 4½d. to 1s. 5½d. per lb.; commercial, £7 9s. 6d. to £8 1s. 6d. per cwt., according to quantity, d/d.

Potassium Prussiate.—Yellow, about 1s. 2d. to 1s. 5d. per lb., supplies scarce.

Salammoniac.—Dog-tooth crystals, £50 per ton; medium, £48 10s. per ton; fine white crystals, £16 10s. per ton, in casks, ex store.

Soda, Caustic.—Solid, 76/77% spot, £14 per ton d/d station.

Soda Crystals.—Spot, £5 to £5 5s. per ton d/d station or ex depot in 2-cwt. bags.

Sodium Acetate.—£37 to £40 per ton, ex wharf.

Sodium Bicarbonate.—About £10 10s. to £11 10s. per ton, in bags.

Sodium Bichromate.—Crystals, cake and powder, 5d. per lb., anhydrous, 6d. per lb. net d/d U.K. Glasgow: 5½d. per lb., carriage paid.

Sodium Bisulphite Powder.—60/62%, £16 per ton d/d in 2-ton lots for home trade.

Sodium Carbonate Monohydrate.—£20 per ton d/d in minimum ton lots in 2 cwt. free bags.

Sodium Chlorate.—£32 10s. to £41 10s. per ton, d/d, according to quantity.

Sodium Hyposulphite.—Pea crystals, £17 15s. per ton for 2-ton lots; commercial, £13 10s. per ton. MANCHESTER: Commercial, £13 10s.; photographic, £17 10s.

Sodium Iodide.—B.P., for not less than 28 lb., 8s. 10d. per lb.; for not less than 7 lb., 10s. 9d. per lb.

Sodium Metasilicate.—£14 5s. per ton, d/d U.K. in cwt. bags.

Sodium Nitrate.—Refined, £9 10s. to £10 per ton for 6-ton lots d/d.

Sodium Nitrite.—£18 15s. per ton for ton lots.

Sodium Perborate.—10%, £4 10s. per cwt. d/d in 1-cwt. drums.

Sodium Phosphate.—Di-sodium, £17 per ton, delivered, for ton lots. Tri-sodium, £21 per ton d/d for ton lots.

Sodium Prussiate.—From 6d. per lb. ex store.

Sodium Silicate.—£8 2s. 6d. per ton, for 4-ton lots.

Sodium Sulphate (Glauber Salts).—£4 10s. per ton d/d.

Sodium Sulphate (Salt Cake).—Unground, Spot, £4 1s. per ton d/d station in bulk. MANCHESTER: £4.

Sodium Sulphide.—Solid 60/62%, Spot, £13 15s. per ton d/d in drums; crystals, 30/32%, £9 10s. per ton d/d in casks. MANCHESTER: Concentrated solid, 60/62 per cent., £13 10s.; crystals, £9 15s.

Sodium Sulphite.—Pea crystals, spot, £16 per ton d/d station in kegs; commercial, £11 per ton d/d station in bags.

Sulphur Precip.—B.P., £55 to £60 per ton according to quantity. Commercial, £50 to £55.

Sulphuric Acid.—168° Tw., £6 2s. 3d. to £6 13s. 3d. per ton; 140° Tw., arsenic-free, £4 7s. 6d. to £4 17s. 6d. per ton; 140° Tw., arsenious, £4 per ton; quotations naked at sellers' works.

Tartaric Acid.—1s. 8d. per lb., less 5%, carriage paid for lots of 5 cwt. and upwards. Makers' prices nominal; imported material 2s. 3d. to 2s. 6d. per lb., ex wharf. MANCHESTER: 1s. 9d. per lb.

Zinc Oxide.—Maximum prices: White seal, £30 17s. 6d. per ton; red seal, £28 7s. 6d. d/d; green seal, £29 17s. 6d. d/d buyers' premises.

Zinc Sulphate.—Tech., about £25, carriage paid, casks free.

Rubber Chemicals

Antimony Sulphide.—Golden, 9½d. to 1s. 7½d. per lb., according to quality. Crimson, 1s. 7½d. to 1s. 11½d. per lb.

Arsenic Sulphide.—Yellow, 1s. 8d. to 1s. 9d. per lb.

Barytes.—Imported material £6 to £9 per ton according to quality.

Carbon Black.—About 7d. to 7½d. per lb., according to quantity.

Carbon Bisulphide.—£31 to £36 per ton, according to quantity, in free returnable drums.

India-rubber Substitutes.—White, 5½d. to 6½d. per lb.; dark 5½d. to 6d. per lb.

Lamp Black.—Imported material is quoted at about £35 to £40 per ton.

Lithopone.—30%, £18 17s. 6d. per ton; 60%, £31 to £32 per ton. Imported material would be dearer.

Sulphur.—Finely powdered, about £15 per ton, delivered.

Sulphur Chloride.—6d. to 8d. per lb., according to quantity.

Vegetable Black.—£35 per ton upwards; 28/30%, £15 10s. 0d.; 60%, £29, delivered buyers' premises.

Vermillion.—Pale or deep, 11s. per lb., for 7 lb. lots.

Plus 5% War Charge.

Nitrogen Fertilisers

Ammonium Sulphate.—Per ton in 6-ton lots d/d farmer's nearest station, March/June, £9 6s.

Calcium Cyanamide.—£12 10s. for 5-ton lots per ton net f.o.r. or ex store, London. Supplies small.

"Nitro-Chalk."—£8 18s. per ton, in 6-ton lots, d/d farmer's nearest station, January/June delivery.

Concentrated Complete Fertilisers.—£11 18s. to £12 4s. per ton in 6-ton lots, d/d farmer's nearest station.

Ammonium Phosphate Fertilisers.—£11 14s. to £16 6s. per ton in 6-ton lots, d/d farmer's nearest station.

Coal Tar Products

Benzol.—Industrial (containing less than 2% of toluol), 2s. to 2s. 1d. per gal., ex works, nominal.

Carbolic Acid.—Crystals, 9d.-11d. per lb.; Crude, 60's, 3s. 3d. to 3s. 6d., according to specification. MANCHESTER: Crystals, 10½d. per lb., d/d; crude, 3s. 9d. to 4s. naked, at works.

Creosote.—Home trade, 4½d. to 5½d. per gal., f.o.r., makers' works; exports 6d. to 6½d. per gal., according to grade. MANCHESTER: 5d. to 7d. per gal.

Cresylic Acid.—99/100%, 2s. 11d. to 3s. per gal., according to specification. MANCHESTER: Pale, 99/100%, 2s. 9d.

Naphtha.—Solvent, 90/160°, 1s. 7d. to 1s. 8d. per gal.; solvent, 95/160°, 1s. 11d. to 2s., naked at works. MANCHESTER: 90/160° 1s. 11d. to 2s. per gal.

Naphthalene.—Crude, whizzed or hot pressed, £10 to £11 per ton; purified crystals, £23 per ton in 2-cwt. bags; flaked, £23 15s. per ton. Fire-lighter quality, £6 to £7 per ton ex works. MANCHESTER: Refined, £34.

Pitch.—Medium, soft, 50s. per ton, f.o.b. MANCHESTER: 50s. to 52s. 6d. f.o.b. East Coast.

Pyridine.—90/140°, 20s. to 25s. per gal.; 90/160°, 18s. 6d. to 19s. 6d.; 90/180°, 4s. to 5s. per gal., f.o.b. MANCHESTER: 19s. to 22s. 6d. per gal.

Toluol.—Pure, 2s. 5d., nominal. MANCHESTER: Pure, 2s. 5d. per gal., naked.

Xylol.—Commercial, 2s. 9d. per gal.; pure, 2s. 11d. MANCHESTER: 2s. 11d. per gal.

Wood Distillation Products

Calcium Acetate.—Brown, £8 10s. to £10 per ton; grey, £13 to £14. MANCHESTER: Grey, £18.

Methyl Acetone.—40.50%, £42-£45 per ton.

Wood Creosote.—Unrefined, 1s. to 1s. 6d. per gal., according to boiling range.

Wood Naphtha, Miscible.—4s. 6d. to 4s. 9d. per gal.; solvent, 4s. 6d. to 4s. 9d. per gal.

Wood Tar.—£5 to £6 per ton, according to quality.

*Intermediates and Dyes

m-Cresol 98/100%.—1s. 8d. to 1s. 9d. per lb. in ton lots.

o-Cresol 30/31° C.—8d. to 9d. per lb. in ton lots.

p-Cresol 34/35° C.—1s. 8d. to 1s. 9d. per lb. in ton lots.

Dichloraniline.—2s. 7d. per lb.

Dinitrobenzene.—8d. per lb.

Dinitrotoluene.—48/50° C., 9d. per lb.; 66/68° C., 11½d.

Nitrobenzene.—Spot, 5½d. per lb., in 90-gal. drums, drums extra, 1-ton lots d/d buyer's works.

Nitronaphthalene.—10d. per lb.; P.G., 1s. 0½d. per lb.

o-Toluidine.—1s. per lb., in 8/10 cwt. drums, drums extra.

p-Toluidine.—2s. per lb., in casks.

m-Xylidine Acetate.—4s. 5d. per lb., 100%.

Latest Oil Prices

LONDON.—June 27.—For the period ending August 3, per ton, net, naked, ex mill, works or refinery, and subject to additional charges according to package and location of supplies:—**LINSEED OIL**, raw, £44. **RAPESEED OIL**, crude, £44 5s. **COTTON-SEED OIL**, crude, £31 2s. 6d.; washed, £34 5s.; refined edible, £35 12s. 6d.; refined deodorised, £36 10s. **SOYA BEAN OIL**, crude, £33; refined deodorised, £37. **COCONUT OIL**, crude, £28 2s. 6d.; refined deodorised, £31 7s. 6d. **PALM KERNEL OIL**, crude, £27 10s.; refined deodorised, £30 15s. **PALM OIL**, refined deodorised, £33. **GROUNDNUT OIL**, crude, £35 10s.; refined deodorised, £40. **WHALE OIL**, crude hardened, 42 deg., £30 10s.; refined hardened, 42 deg., £33. **ACID OILS**—Groundnut, £24; soya, £22; coconut and palm kernel, £22 10s. **ROSIN**, 25s. to 30s. per cwt., ex wharf, according to grade. **TURPENTINE**, 53s. per cwt., spot, American, including tax, ex wharf, barrels, and ex discount.

HULL.—June 26.—American turpentine, spot, 54s. 6d. per cwt. in barrels ex store.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for errors that may occur.

Mortgages and Charges

(Note.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every company shall, in making its Annual Summary, specify the total amount of debt due from the company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.)

W. F. METCALE, LTD., Southport, chemical manufacturers. (M., 29/6/40.) June 15, debenture to Barclays Bank, Ltd., securing all moneys due or to become due to the Bank; general charge. * Nil. October 7, 1938.

Notice of Intended Dividend

FREEMAN, NAT HARRIS, Chartridge Grange, Chesham, Bucks, experimenting manufacturing chemist. Payable July 9, 1940, 29 Russell Square, London, W.C.

County Court Judgments

RUTTER-HARBOTT, REUBEN, GEO., St. Brenden, Blake Hall Crescent, E.11, manufacturing chemist. (C.C.J., 29/6/40.) £66 19s. 10d. March 14.

PHOENIX PROPRIETARIES, LTD., Imperial Works, Ryland Road, N.W.5, manufacturing chemists. (C.C.J., 29/6/40.) £12 16s. 3d. April 30.

Companies Winding-Up Voluntarily

STANDARD ALLOYS, LTD. (C.W.U.V., 29/6/40.) General meeting of Members, Connaught House, 63 Aldwych, London, W.C.2, on Monday, July 22, 1940, at noon.

CARBO PLASTER, LTD. (C.W.U.V., 29/6/40.) Creditors' claims by July 26, 1940, to Sir Harold Moore, Chartered Accountant, of Moore Stephens and Co., 4 London Wall Avenue, London, E.C.2.

Company News

Titanine, Ltd., report a profit for the year to March 31, 1940, after tax provision, of £32,263, as against £31,600 last year. A final dividend of 12½ per cent., making 22½ per cent., less tax (the same) has been declared.

Clover Paint and Composition Co., Ltd., announce a profit for the year to April 30, 1940, of £12,097 (£10,696). Final ordinary dividend 3½ per cent., making 6 per cent. (2½ per cent.); forward, £20,745 (£22,148). Meeting, 11 Waterloo Place, S.W., July 3.

International Toxin Products, Ltd., 5 Chapel Street, Liverpool, 3, have increased their nominal capital by the addition of £9500 beyond the registered capital of £1000. The additional capital is divided into 5500 ordinary and 4000 10 per cent. non-cumulative preference shares of £1.

The Standard Chemical Co., Ltd., Canada, report an operating profit for the year to March 31, 1940, of \$150,432 (\$119,502), with a net profit of \$57,330 (\$40,420). Sales for the year amounted to \$1,684,197, an increase of \$278,116 over the previous year. An interim dividend of 50 cents per share was paid on April 15, and a final dividend of 75 cents per share on June 15, making \$1.25 for the year (50 cents previous year).

E. Griffiths Hughes, Ltd., the operating company of Griffiths Hughes Proprietaries, Ltd., made a trading profit of £174,739, against £106,570, and, with other income higher than a year ago, total income amounted to £190,968, compared with £117,756. Although the directors have created a reserve of £35,550 in respect of assets in certain European countries, this still leaves the net profit well up at £155,418, against £112,550. Taxation is nearly doubled at £69,780. The parent company receives £86,175, against £93,069, in tax-free dividends, and this enables it to maintain its ordinary distribution at 5 per cent., less tax, with the payment of a final of 3 per cent., and to carry forward £446, compared with £2236 brought in.

New Companies Registered

Klarzone, Ltd. (362,016).—Private company. Capital £1000 in 1,000 shares of £1 each. Manufacturers of and dealers in disinfecting preparations and materials, disinfectants and deodorisers, etc. Permanent directors: Walter Parkinson, and Frank L. Parkinson. Registered office: Red Cross Street, Preston.

La Barre Marshall Enamels, Ltd. (361,849).—Private company. Capital £100 in 100 shares of £1 each. Manufacturers of and wholesale and retail dealers in enamels and enamel products, paints, varnishes, polishes, etc. Directors: George La Barre, Wm. Marshall. Registered office: 20 Queen Street, Wolverhampton.

Scottish Petroleum Products, Ltd., 349 Gallowgate, Glasgow. Private company. Capital, £100 in £1 shares. Importers and exporters of, and wholesale and retail dealers in, petroleum, kerosene, white oil, lubricating oil, crude oils, etc. Directors: Mrs. Marion Walker White and Aitken Cameron Ferguson.

Bruton Engineering Company, Ltd. (361,959).—Private company. Capital £500 in 500 shares of £1 each. Mechanical, electrical and chemical engineers, designers and manufacturers of machinery, etc. Directors: Arthur S. Smith, Richard G. Holloway. Acting secretary: C. M. Roberts. Solicitors: White and Leonard and Nicholls and Co., 4 St. Bride Street, E.C.4. Registered office: 32 Bruton Place, W.1.

Nixit Company, Ltd. (361,808).—Private company. Capital £100 in 100 shares of £1 each. Manufacturers of and wholesale and retail dealers in chemicals, gases and disinfectants of all kinds, dyes, pigments, acids, drugs, powders, medicines, etc. Directors: Leslie F. Nixon, Adeline M. Nixon. Solicitor: Stanley N. Walton, 25 Bondgate, Darlington. Registered office: St. Helens Trading Estate, St. Helens, Bishop Auckland.

Palorit, Ltd. (361,507).—Private company. Capital, £100 in 100 shares of £1 each. Manufacturers of and dealers in varnishes, paints, enamels, pigments, paint bases, white and other leads, chemicals, brushes and all kinds of toilet and cosmetics preparations, etc. Directors: Walter B. Farlow, James W. Latham, Alfred E. H. R. Averman, Nicholas Pal, Adrian F. H. S. Simpson and Reginald Stamp. Secretary: Laurence E. Shaw. Registered office: 83 Scrubbs Lane, N.W.

Chemical and Allied Stocks and Shares

BUSINESS on the Stock Exchange has again been confined to British Funds, and industrial securities have shown further declines on balance. Sentiment continued to be influenced by the fear that, partly owing to the possibility of air-raid damage to factories and works, a very conservative dividend policy is likely to be followed. The decision of "Shell" Transport not to pay a final dividend, thus limiting the payment for the past year to the 5 per cent., tax free, interim dividend, had a widespread influence on markets generally, but later the reduced prices attracted some buying.

Imperial Chemical, which had gone back to 18s. 3d., subsequently showed a small rally to 19s. 4½d. while the 7 per cent. preference units, which were no better than 23s. 9d. at one time, later recovered to 24s. 6d. x d. Dunlop Rubber after declining to 20s. 6d., recovered to 22s., while Wall Paper deferred units rallied 1s. 3d. to 40s. Courtaulds was another share which showed a somewhat better tendency later in the week, but movements in most other textile securities were again reactionary, including Lonsdale ordinary and British Celanese second preference. Metal Box shares were unable to move against the general market trend, despite the sharp advance in profits shown by the company's results for the year ended March 31 last.

B. Laporte remained around 50s., while William Blythe 3s. shares continued to be quoted at 6s. 3d., and British Drug Houses at 22s. 6d., but quotations did not appear to be tested by actual business. On balance Borax Consolidated have gone back from 22s. 6d. to 18s. 9d., and British Match from 28s. 9d. to 25s. Cerebos ordinary were marked down from £7½ to £6½, but as in other directions, the decline in price was out of all proportion to the amount of selling, which in this case was described as very small. The current trend in share values arises largely from the continued absence of demand and includes the securities of companies whose prospects are regarded favourably. Under existing market conditions, questions of dividend prospects and other factors which usually govern the trend in values, have little influence on sentiment.

Monsanto Chemicals 5½ per cent. preference continued to be quoted at 21s. 3d., and business in Sanitas Trust 10s. shares was recorded at 12s. Blythe Colour 4s. shares continued to have a quotation of 7s. 6d., but were inactive. Valor ordinary were marked down to 15s., and British Oil and Cake Mills preferred ordinary were 30s., which compares with 33s. 9d. a week ago. Lever and Unilever were no better than 15s., while Distillers, which were 52s. a week ago, have since moved down to 47s. 6d., and United Molasses were 16s. 3d., compared with 18s. 3d. International Paint were 68s. 9d. at one time, but later showed a partial rally to 70s.

In other directions Boots Drug were 28s. 9d. and Timothy Whites 17s., while Beechams Pills 2s. 6d. deferred shares were 6s. 9d., or virtually the same as a week ago, and Sangers ordinary were quoted at 18s. 1½d. Cellon 5s. ordinary remained at 13s. 9d. but were inactive. Barry and Staines went back to 17s. 6d., and Michael Nairn to 52s. 6d. The last named, however, were firmly held on hopes that the forthcoming interim dividend may be maintained. Tube Investments, Stewarts and Lloyds and other iron, steel and allied securities were lower in accordance with the general trend on the Stock Exchange, but selling was not heavy. Similar remarks apply to oil shares, which have been influenced by the decision of "Shell" Transport not to pay a final dividend for the past financial year.

Inventions in the Chemical Industry

The following information is prepared from the Official Patents Journal. Printed copies of Specifications accepted may be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, at 1s. each. The numbers given under "Applications for Patents" are for reference in all correspondence up to the acceptance of the Complete Specification.

Applications for Patents

PROCESS FOR THE MANUFACTURE OF SYNTHETIC BALSAM OF CONDENSATION.—L. C. F. Pechin. (Belgium, March 23, '39.) 5460.

MANUFACTURE OF CALCIUM HYPOCHLORITE COMPOUNDS.—D. M. Rogers and C. I. B. Voge. 5514.

MANUFACTURE OF 17-VINYLTOSTERONE or enol derivatives thereof.—Soc. of Chemical Industry in Basle. (Switzerland, April 1, '39.) 5505; (Switzerland, Feb. 27.) 5506.

THIAMIN COMPOSITIONS.—Standard Brands, Inc. (United States, March 24, '39.) 5439.

Complete Specifications Open to Public Inspection

PROCESS FOR THE PRODUCTION OF CERIUM DIOXIDE.—Deutsche Gold und Silber-Scheideanstalt vorm. Roessler. Sept. 5, 1938. 25238/39.

PRODUCTION OF ORGANIC COMPOUNDS.—Kodak, Ltd. Sept. 7, 1938. 25335/39.

MANUFACTURE OF LUMINOUS AND OTHER PLASTIC MOULDINGS, luminous paints, inks, and the like.—I. Baldwin, and I. McNeil. Sept. 13, 1938. 25347/39.

METHOD OF PRODUCING PLASTIC CONTAINERS.—Monsanto Chemical Co. Sept. 16, 1938. 25366/39.

METALLURGICAL FURNACES.—L. B. Lindemuth. Sept. 7, 1938. 25376/39.

PROCESS FOR THE PRODUCTION OF STILBENE DYESTUFFS.—J. R. Geigy A.-G. Sept. 13, 1938. 25677/39.

MANUFACTURE OF GLYCOLIC ACID ESTERS.—E. I. du Pont de Nemours and Co. Sept. 14, 1938. 25697/39.

TREATMENT OF POLYMERIC MATERIALS.—Imperial Chemical Industries, Ltd. Sept. 14, 1938. 25698/39.

MANUFACTURE OF THIOAMIDES.—Imperial Chemical Industries, Ltd. Sept. 15, 1938. 25699/39.

POLYMERIC COMPOUNDS suitable for filaments, films, coating-compositions, plastics, and the like.—E. I. du Pont de Nemours and Co. Sept. 15, 1938. 25701/39.

MANUFACTURE OF META-ORYPHENYL-ETHANOLAMINE.—Soc. of Chemical Industry in Basle. Sept. 14, 1938. (Cognate Application, 25738/39.) 25737/39.

MANUFACTURE OF QUATERNARY AMMONIUM COMPOUNDS.—E. I. du Pont de Nemours and Co. Sept. 15, 1938. 25700/39.

MANUFACTURE OF OXYARYLAMINOMETHYLKETONES.—Soc. of Chemical Industry in Basle. Sept. 14, 1938. (Cognate Application, 25740/39.) 25739/39.

MANUFACTURE OF LACTONES of the cyclopentanopolyhydrophenanthrene series.—Soc. of Chemical Industry in Basle. Sept. 15, 1938. (Cognate Application, 25833/39.) 25832/39.

MANUFACTURE OF ADENOSINE.—Soc. of Chemical Industry in Basle. Sept. 16, 1938. (Cognate Application, 25835/39.) 25834/39.

MANUFACTURE OF DERIVATIVES of the cyclopentanopolyhydrophenanthrene series.—Soc. of Chemical Industry in Basle. Sept. 13, 1938. (Cognate Application, 26617/39.) 26616/39.

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Metallurgical Section

January 6, 1940

ELECTRIC PIG-IRON FURNACES IN WAR TIME

By
C. C. DOWNIE

SHOULD war-time conditions continue for any length of time, it is possible that every effort will be made to conserve and utilise metalliferous waste as far as possible, so as to be more independent of imported supplies.

Up to the present time, electric pig-iron furnaces have only secured a footing where the cost of electric power is low compared with that of fuel. Such conditions do not obtain in this country. The result, broadly, is that vast accumulations of turnings and borings are to be seen, which are only slowly utilised, partly by briquetting, and partly by adding in small proportions to electric steel charges and cupolas. After the last war blast furnaces were stated to have utilised as much as 25,000 tons per month, but since then the figure has diminished, and the work was admitted to be far from economical.

Unless carefully controlled, charging directly into the ordinary blast furnace is a wasteful process, but it is capable of dealing with vast tonnages at a time. On the other hand, the electric pig-iron furnace, as used by Swedish firms, treats iron turnings with the same ease as iron ore. There is no blast to clog, there is nothing to hinder operations proceeding smoothly and rapidly and the same large tonnages are handled. Comparisons of the respective advantages of blast furnace and electric pig-iron hearth have been widely dealt with, and need not be repeated, but it has to be admitted that the former uses far more than the calculated amount of fuel, and requires air to burn it whereby enormous quantities of dilute combustion gases have to be heated up.

Despite scientific achievements, there is no evidence of the standard blast furnace being displaced by electrothermal methods. Allmand has maintained that the electric pig-iron furnace will begin to compete with the blast furnace when 1,920 K.W.H. (or 2,300 K.W.H. if the furnace gases be taken into account) are cheaper than 0.7 ton coke. Bibby considers that the two processes will be on a par when the price of one H.P. year is equal to 2.3 tons of coke.

The total volume of gases produced per ton of pig iron in the electric furnaces, is approximately one-seventh of that obtained from blast furnace practice, whilst its calorific power is in the ratio of 2.5 : 1. (Durrer). Such gases are eminently suitable for all kinds of industrial purposes, which cannot be claimed for blast furnace gases, since they are free from nitrogen and contain upwards of 64 per cent. of carbon monoxide. Durrer's analysis of the two furnace gases is as follows: Electric furnace, 64 per cent. carbon monoxide, 22 per cent. carbon dioxide, 12 per cent. hydrogen, 2 per cent. methane. Blast furnace, 28 per cent. carbon monoxide, 10 per cent. carbon dioxide, 3 per cent. hydrogen, 1 per cent. methane, 58 per cent. nitrogen. The argument in favour of the electric pig-iron furnace might be considered closed from a purely scientific viewpoint, but the high costs of current have prevented displacement of the blast furnace, which continues to be developed.

With a continuance of war-time conditions, the question of costs might not be of such importance, particularly if a shortage of imported ores arose, and less time was available for coke production. Turnings and borings, apart from other types of metalliferous waste, can be most scientifically con-

verted to pig-iron, from a supply which would tend to be an ever-increasing one.

Utilising fine metallic material in the blast furnace is entirely dependent upon ore being present as the major constituent, apart from the fact that undue losses are sustained. The higher the percentage of turnings included in the charge, the higher are the melting losses, and although records show that as much as 50 per cent. turnings were tried, this was not persevered with. Should it happen that ore supplies become restricted, the chances of utilising metalliferous waste would become correspondingly more remote, since the blast furnace could not cope with this material alone. Alternatively, the electric pig-iron hearth can provide the highest grade of pig-iron without losses, from, if so desired, a charge composed almost entirely of turnings and borings. During the last war chemical processes, which, from an economic standpoint, would not have been considered during normal times, were adopted. The same latitude may have to be employed in this war when considering the electrothermal production of pig-iron. The construction of the electric pig-iron hearth is not complicated; it is equipped with transformers and electrodes much in the same manner as ordinary electric steel furnaces.

Although students of metallurgy in this country are not given opportunities of studying this work, students at the Technical High School, Stockholm, receive practical training.

Supplies of pig-iron for foundry and open-hearth use are at present almost entirely dependent upon unrestricted imports, but once electric furnaces were adopted, the country would be completely independent of any outside assistance.

As an example of the working of blast furnace and electric hearth, the sum of the heat carried away by the gases, and heat produced by oxidation of carbon monoxide to dioxide, amounts to 4,600,000 calories per ton of iron with the former, and only 1,150,000 calories with the latter. Where the charge is largely composed of thermal conductive material, such as iron and steel turnings, the disparity is still greater. Should the electric pig-iron furnace be considered as a means of ensuring pig-iron supplies despite the greater working costs, hearths might be set up in different industrial districts, so as to obviate excessive transport, and prevent excessive rust developing on exposed metal, as it is at present.

APPLIED SPECTROGRAPHY

Industrial Application of Spectrography in the Non-Ferrous Metal Industry is the title of a pamphlet reprinted from the *Journal of the Institute of Metals* and published by the Institute at 4 Grosvenor Gardens, S.W.1. (2s. 6d.) It consists of a paper by Mr. F. Twyman, F.R.S., of Adam Hilger, Ltd., describing the principles and modern methods of spectrographic analysis, together with a discussion which took place at a general meeting of the Institute. Hitherto unpublished results of a highly important character are contained in the contribution of Dr. Frommer, who describes in detail the methods worked out for the large-scale routine analysis of light alloys. Professor Breckpot deals with the current practice in Belgium, and M. Gauthier with that in France.

Current Topics

Insulation of Open Hearth Furnace Roofs

OWING to the exceptionally high temperatures developed in the upper zone of basic open-hearth furnaces it has been the practice in European steelworks to refrain from insulating the silica roofs owing to the supposed risk of premature breakdown. In the U.S.A., on the other hand, steelmakers have demonstrated that such a danger does not exist and that, in fact, the insulation of furnace roofs prolongs their life in addition to effecting fuel economies of 10-20 per cent. Several European refractory materials capable of standing up to the high temperatures involved have recently been examined in this connection by Dr. J. Robitschek and Dr. F. Singer (*Revue Universelle des Mines*, 1939, Vol. 15), who arrive, both on theoretical and practical grounds, at the conclusion that the American practice of furnace roof insulation is amply justified. For efficient heat insulation of the silica roofs a material is demanded which does not begin to fuse below a temperature of 1400°C . (the interior temperature of the furnace being in the vicinity of 1100°C .), and which possesses at this high temperature a mechanical strength sufficient to withstand the expansive movements of the roof itself.

Refractory Coatings

THE production of refractory coatings with metallic aluminium is described by Schurecht (*J. Amer. Ceram. Soc.*, 1939, 22, 11, 384-388). The protection of furnace refractories with metallic aluminium alone (applied by spraying) is unsatisfactory in thicknesses greater than 0.01 inch, due to flaking of the aluminium caused by the unequal expansions of metal and base. To get a greater thickness the aluminium must be made into a slip with clay, and experiments showed that a mixture of 90 parts of metal with 10 parts of fireclay was capable of producing adherent coatings of up to 0.03 inch. For greater thicknesses a higher proportion of clay is necessary. When this coating is fired on, a form of thermite reaction occurs, starting at $750-900^{\circ}\text{C}$., and raising the temperature of the refractory base locally to about 1400°C . Such coatings give a definite protection to the base against corrosion by portland cement clinker and blast furnace slag, but actually increase the corrosion experienced with lead blast furnace slag and soda-lime glasses.

Canada's Mineral Production in 1939

THE High Commissioner for Canada in London is informed by cablegram from Ottawa that mineral production in Canada during 1939 is estimated to have reached a total value of \$470,179,000, the highest figure yet achieved, representing an increase of 6 per cent. over the previous year, and of 3 per cent. over 1937, when the previous highest total was reached. New output records are reported for antimony, gold, copper, zinc, nickel, cadmium, crude petroleum, natural gas, gypsum, sulphur and lime. Several new gold mines reached the production stage, and the gold productive field was widened. Iron ore was produced on a commercial scale for the first time in sixteen years at Michipicoten, and this was perhaps the most significant development of the year in the mining industry. A considerable amount of prospecting and development work occurred in connection with the search for those metals and ores which have not as yet been pro-

duced to any great extent in Canada, but which are important for war purposes in the manufacture of various alloys. These metals include molybdenum, manganese, mercury and tungsten.

Uganda Ores

ACCORDING to the annual report of the Geological Survey of Uganda for the year 1938, reported in the Bulletin of the Imperial Institute, the output of cassiterite in the colony continued to expand. The production of tantalite was less owing to the fall in the price realised, the fact that the tantalum content of many of the Uganda ores is not particularly high, and the lack of persistency of the lodes. It is hoped, however, that deposits of high grade will be found in Buhwezu, where heavy mineral concentrates, more particularly from the alluvial deposits of the Jamubi river, and even near its source at the foot of an escarpment, have been proved to contain much tantalite with a Ta_2O_5 content of 60 per cent. A small quantity of wolfram was again exported and, for the first time, half a ton of bismutite, the natural bismuth carbonate. Judged by the surface indications, the wolfram lodes are considered promising and are to be explored by means of adits driven into the steep Kigezi hillsides. Chemical analysis and mineralogical examination at the Imperial Institute of some large lumps of an unusual mineral from a locality 7 miles S.S.W. of Kagade showed it to be euxenite, a complex columbate and titanate of uranium and rare-earth metals.

The Ablett Prize

THE Council of the Iron and Steel Institute have accepted an offer from Captain C. A. Ablett, O.B.E., again to present a prize of £50 for the best paper on a subject connected with engineering in iron or steel works. The sole condition is that the paper must be written by a junior engineer employed in a works in Great Britain or the British Empire. The author need not be a member of the Institute. Authors are invited to compete for the prize; papers should be marked "Ablett Prize Paper," and must reach the Secretary (complete with illustrations, tables, etc.) not later than February 28, 1940. The successful paper will be presented at the annual meeting in May, 1940, and published in the *Journal of the Institution*. The Council may agree to publish more than one of the papers submitted. The decision of the Council is final as to whether a paper is eligible and on all matters arising out of the award of this prize.

The Williams Prize

THE award of the Williams Prize to the author (or authors) of that paper of a practical character which shall be judged to be the best one of that kind published in the *Journal* during the year is likewise being continued by the Council of the Institute. The prize is of the value of £100, and the conditions governing the award are that the author shall be a British subject regularly employed in a British iron or steel works, and that at the time of presenting the paper he shall be employed in such works in a position not superior to that of manager of any one technical department; he need not be a member of the Institute. All papers of the character accepted for publication by the Institute which are eligible are considered for the award of this prize; papers need not be specially submitted.

New Classification of Commercial Copper

Obsolete Terms Abolished

A NATIONAL emergency such as the present is always an occasion for much upheaval and readjustment, but it sometimes provides a long-awaited opportunity to revise an existing order of things and to introduce something better to the lasting benefit of all concerned. One such instance is to be found in the copper industry.

Those interested in this industry will notice that in the recently issued Control of Non-Ferrous Metals (No. 5) Order, 1939, a new and perhaps rather unfamiliar classification of commercial copper has been included, as follows:—

- (1) High conductivity electrolytic copper.
- (2) Fire-refined copper sold or intended to be sold as high conductivity copper.
- (3) High grade fire-refined copper.
- (4) Fire-refined copper of ordinary quality containing not less than 99.7 per cent. of copper.
- (5) Fire-refined copper containing not less than 99.2 per cent. of copper.
- (6) Black hot-rolled copper wire rods.

Though this classification will no doubt be criticised, it shows evidence of a praiseworthy attempt to place the grading of copper on a more logical and scientific basis than hitherto. It will be noted that such obsolete and ill-defined terms as "Best select," "Fine," "Tough," etc., are absent.

On the other hand, the view may be taken that the new classification does not go far enough and is neither as complete nor as definite as it might be, but presumably it is a compromise based on many conflicting factors which have had to be taken into account to meet the present abnormal state of affairs and to interfere as little as possible with established commercial practice. It will also be appreciated that in the present circumstances sources of supply are necessarily limited, and certain brands of metal may no longer be available. Little difficulty should be experienced, however, in obtaining suitable substitutes from sources within the Empire.

Copper of grades (1) and (2) in the classification will conform to the recognised standards for high conductivity metal and these grades as well as grades (4) (5) and (6) do not call for any particular comment. In the case of grade (3), however, it will be noted that no details are given of what the term "High Grade Fire-Refined Copper" is intended to cover, but it is evident that it is designed to include that large category of first quality fire-refined copper, much of which has in the past originated from Chilean and, more recently, African sources, of which such brands as C.F.R., Braden * * *, M.T.D., B.C.R. and E.R.M. are examples. In nearly all cases the minimum copper content of this grade would be approximately the same as that of the high conductivity grades (i.e., about 99.88 per cent.).

Arsenical Copper

While the new classification is based primarily on conductivity and copper content, and indirectly on impurities, provision has been made to include also certain categories of copper containing very small amounts of specified constituents such as arsenic, cadmium, etc. For the purpose of classification the specified constituents are to be counted as copper. Thus, for instance, arsenical copper containing over 99.3 per cent. copper and nominally 0.4 per cent. arsenic would be classed not as grade (5) but as either arsenical grade (3) or (4) according to its combined content.

The need for a more rational classification of copper has long been recognised among progressive producers and users of the metal, and, although the new grading may not be ideal for adoption in all future circumstances without amplification or adjustment, it should be welcomed as the foundation upon which a better and more logical order of things in the copper industry can be established.

Foamed Blast Furnace Slag

New British Standard

A BRITISH Standard for Foamed Blast Furnace Slag for Concrete Reinforcement (B.S.877) has just been issued by the British Institution. The specification is the first of a series which is in preparation for concrete aggregates generally. The standard for foamed blast furnace slag has been based on research carried out by the Building Research Station in collaboration with the Blast Furnace Committee of the Iron and Steel Industrial Research Council.

The standard is restricted to material having a lime content within 50 per cent. and the requirements included cover weight per unit volume, impurities (electrical test), combustible matter (ignition test), stability, and presence of sulphate. Details of the methods by which the various tests have to be carried out are given in the appendices. It is recommended that concrete made with this aggregate should not be used for outside work without the protection of a rendering.

Copies of the above standard may be obtained from the British Standards Institution, Publications Department, 28 Victoria Street, London, S.W.1, price 2s. each (2s. 2d. post free).

The Demand for Aluminium

Service Demands Absorbing Entire Output

REFERENCES to the present position of aluminium and its importance in armament production are made in a statement issued by a high executive of a leading firm in the aluminium industry.

"Aluminium is playing a very big part to-day in war material production," says the statement. "All the metal available in this country is now urgently required for war work. Its lightness, ductility and high power-to-weight ratio make aluminium essential for the construction of modern high-speed aircraft. It is used, not only in the manufacture of aeroplane frames, "skins," propellers and other parts, but in the engines, and the demand from the R.A.F. as well as from the Navy and Army absorbs the entire output.

"Some concern has been expressed by a number of trades at the present lack of aluminium for industrial purposes. The foil and hollow-ware trades, for example, have complained that many manufacturers may have to close down because of the shortage, and the Public Service Transport Association has represented to the Minister of Transport that the lack of aluminium supplies has raised weight difficulties which necessitate waiving of the present maximum laden weight limits of buses and trolley vehicles.

"The aluminium industry is fully aware of the inconvenience that may be temporarily imposed on industrial manufacturers, but it will be appreciated that Service needs must come first.

"There is no doubt that the present demand for aluminium semi-manufactured products such as sheet, tubes, structural sections and stampings, will result in the development of new and stronger alloys. Already, too, the increased production has resulted in reductions of manufacturing costs as the result of standardisation and experience gained with new processes and more up-to-date machinery."

DOLOMITE AND THE STEEL INDUSTRY

Mr. A. W. Comber, of whose recent Streetfield Memorial Lecture we gave a brief review in the last Metallurgical Section of THE CHEMICAL AGE (December 2, 1939; p. 31), asks us to clear up the possibility of a slight misunderstanding in the second paragraph of our review, headed "Replacement by Dolomite." With the exception of the first 3½ lines, the earlier part of this paragraph relates to the steel industry, but the remainder, from the 13th line onwards, to the production of magnesium metal.

Some Recent Metallurgical Patents

Beryllium Articles : Wet Separating

Beryllium articles are made by purifying powdered beryllium by treatment with concentrated nitric acid, freeing the powder from the acid, converting it by compression at high pressures (e.g. 10-30 tons per square cm.) into products of the desired shape, and subjecting the shaped products to a sintering process at temperatures from 900-1,250° C. in an inert atmosphere, preferably in a vacuum. The powder may also be pretreated by subjecting it to gravity separation from beryllium oxide and other oxide particles. Suitable separating agents are ethylene bromide, acetylene tetrabromide, or bromoform, and lighter liquids such as benzene, toluene, or carbon tetrachloride may be added thereto. The invention is suitable for sheets, discs, cylinders, and thin-walled articles. (See Specification 508,028 to Deutsche Gold- und Silber-Scheideanstalt Vorm. Roessler).

Alloy Steel : Heat Treatment

Welded constructional elements, for example for aircraft, having a minimum strength at the weld of 60 kilograms per square millimetre without brittleness, are made from an alloy steel capable of precipitation hardening and containing 0.05-0.25 per cent. of carbon, 0.25-5.0 per cent. of copper, and one of the following additions: 0.8-10.0 per cent. of manganese, 0.5-3.0 per cent. of silicon, 0.2-3.0 per cent. of chromium, 0.5-5.0 per cent. of nickel, 0.5-3.0 per cent. of molybdenum, 0.2-1.0 per cent. of vanadium, 0.5-3.0 per cent. of tungsten, 0.1-0.5 per cent. of zirconium, or 0.1-0.5 per cent. of phosphorus, but no titanium. Two or more of the additional elements may be present in lesser quantities to give the desired properties. The steel may be subjected to precipitation hardening by tempering between about 400 and 800° C., and preferably between about 450 and 700° C., with or without a previous normalising treatment, or it may be normalised only. Specification 445,842 is referred to. (See Specification 506,641 of Schoeller-Bleckmann Stahlwerke A.-G.)

Alloys : Electric Furnaces ; Rolling

Articles such as rolling-mill rolls are formed from powdered material containing metal carbides and a metallic binder by compressing the material in a mould and locally and progressively heating the material in a zone moving in the direction in which pressure is exerted. The heating may progress from one end to the other or from the centre outwards to the ends of the mould. The articles formed may be solid or tubular. The carbides may be tungsten, molybdenum, vanadium, chromium, tantalum, or titanium, and the metal may be iron, cobalt, or nickel. The material is placed in a carbon or graphite mould surrounded by carbon packing, an insulating sheath and electric heating coils. The mould may be of refractory material such as magnesite, zirconia, and chromite. Compression is effected by a plunger or forging hammer operated hydraulically. In one form, small slugs of the powder are successively formed in the mould under heat and pressure and progressively welded together. Thus, powder for the second slug is placed on the preformed slug. Smaller intermediate portions of the powder may be compressed between each slug to assist in welding. The slugs may be formed outside the mould under pressure, with or without heating, then superposed in the mould and welded together by progressive heating under pressure. Rings or tubes may be formed similarly in a mould by means of a spindle and an annular piston. The material may be compressed by opposed pistons. When the mould is made of refractory material such as magnesite, the heating is effected by induction. The heating coils may be individually controlled so that the heating zone can be progressively moved or the heating coils may themselves be moved along the mould. The hollow cylinders may be used as working surfaces for rolls and may be provided with central shafts of steel or other metal which may be cast therein or secured thereto. The rolls may be mounted in a four-high mill. (See Specification 506,728 to Metal Carbides Corporation).

Alloys

Alloy steels suitable for high speed tools contain 0.7-1.8 per cent. of carbon, 2.1-15 per cent. of tantalum or niobium or both, and 0.3-5 per cent. of vanadium, with or without any of the following: up to 6 per cent. of chromium, up to 20 per cent. of cobalt, and up to 5 per cent. of tungsten or molybdenum or both. The tantalum or niobium may be partly replaced by the same amount of titanium. (See Specification 507,983 to Deutsche Edelmetallwerke A.-G.).

Deoxidising Steel

In the deoxidation of steel baths with calcium carbide, the melting point of the calcium carbide and its reaction products is reduced to below the melting point of the steel by the addition of one or more of the fluorides of alkali and alkaline earth metals and aluminium, the carbide content of the mixture used being at least 50 per cent. Oxides and carbonates of alkali and alkaline earth metals and aluminium in an amount up to 10 per cent. may be added to the carbide mixture especially when the latter contains fluorspar and cryolite. Specifications 1947/02, 18962/09, [both in Class 72], and 395,158 are referred to. (See Specification 508,012 to Rochling'sche Eisen und Stahlwerke Ges.).

Iron Powder

In the production of iron powder by the reduction of iron oxide by hydrogen, powdered iron is moistened with water in the presence of small quantities of an iron halide and exposed to the action of the air, preferably with stirring, at moderate temperature, say 120-200° C., being maintained, the oxidation product so obtained being reduced by hydrogen at 500-600° C. Before its reduction, the oxidation product may be heated to 350-400° C., preferably in the presence of air, say in a rotary furnace. The iron halide is preferably ferrous chloride, and it may be produced by adding ammonium chloride or hydrochloric acid to the powder when it is moistened. The resultant iron powder is of great fineness and reactive capacity and of very low bulk weight. Its content of metallic iron may be raised by subjecting it to a second reduction with hydrogen. (See Specification 507,277 to Deutsche Gold- und Silber-Scheideanstalt Vorm. Roessler).

PRETORIA STEELWORKS EXTENSION

The South African Iron and Steel Industrial Corporation, Ltd., have placed with the Woodall-Duckham Vertical Retort and Oven Construction Co. (1920), Ltd., an order for a second complete by-product coking installation to be built at their Iscor Steelworks near Pretoria. The value of this order is just on £475,000.

The new oven battery will comprise 45 top-charged, W-D Becker coke ovens designed for blast furnace gas underfiring. The ovens will be 40 ft. 8 in. long, 13 ft. high and 16 in. average width, and the battery will be capable of carbonising 960 tons of washed coal a day. The new battery will be laid out on a new site, but on the by-product side advantage will be taken of the original facilities for extension.

The contract provides for 2 sets of electro-detarrers for the extended plant, and for a new concentrated ammonia plant capable of manufacturing liquor of 25 per cent. strength. The capacity of the benzol plant will be doubled, provision being made at the same time for the production of pure toluol. Finally, a pipe-still type of tar distillation plant has been adopted to deal with 100 tons of crude tar per day and this installation will produce finely cut fractions including a suitable wash oil for benzol recovery.

FRENCH CHEMICAL MANUFACTURERS have received circulars from the Direction of Explosives and Chemical Products, asking for their expected consumption of chemical products for the first quarter of next year.

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Metallurgical Section

February 3, 1940

SCARCITY OF COPPER AND ZINC IN GERMANY

I.—An Analysis of the Copper Position

By

D. D. HOWAT, B.Sc., A.Inst.M.M., A.I.C., Ph.D.

COPPER and zinc are metals vital to a nation engaged in modern warfare; the mechanisation of armies, the demands of an air force and the equipment of naval vessels all call for large amounts of these metals. The principal uses of copper are, of course, in the electrical industry and a high-purity metal is essential for almost all the jobs in this industry. The two outstanding properties of copper that account for its extensive use in the electrical field are its high conductivity and its high ductility, and these two properties are developed to their maximum degree in high-purity metal only. Electric motors, telephones, wireless receivers and transmitters, cables, generators, and the intricate ignition systems of internal combustion engines constitute some of the almost insatiable demands for high-purity copper in the armament industry. The metal is employed also in the manufacture of brasses and bronzes for tubes, valves, propellers and for anti-corrosion purposes generally. Cupro-nickel alloys are used for condenser tubes, for steam-turbine blading and for electrical resistance elements. Copper is also an essential constituent of all the very important group of "light alloys," containing upwards of 90 per cent. aluminium, which are used so extensively in the construction of high-speed aeroplanes.

The figures for world consumption of copper have shown a decided increase during the past two or three years and, naturally, the increase has been particularly marked in those countries where the demand for armaments has been a dominant feature, for example, in Germany and Japan. Some typical figures are as follows:—

COPPER CONSUMPTION IN METRIC TONS.

	1936.	1937.	1938.
World total	1,894,500	2,184,300	1,975,700
Germany	185,300	228,300	339,000
Japan	126,300	183,000	201,000
Britain	258,500	303,600	258,800
United States	733,900	796,700	473,300
France	113,400	123,000	—

So far as the great copper producing centres are concerned Germany is very unfavourably situated to receive supplies of this vital metal in war so long as the allied navies of Britain and France remain in control of the seas.

World Producing Centres

The most important centres in the world for the production of copper ore are:—U.S.A., Northern Rhodesia, Canada, Belgian Congo and Chile, with Russia barely qualifying for a place in this list. The figures for the three years 1935 to 1937 are as follows:—

PRODUCTION OF COPPER ORE (in terms of metal) IN LONG TONS.

	1935.	1936.	1937.
World Total	1,470,000	1,700,000	2,300,000
U.S.A.	339,723	548,674	748,009
Northern Rhodesia	168,659	170,728	245,888
Canada	187,053	187,959	236,620
Belgian Congo	105,981	94,150	148,210
Chile	262,864	252,162	410,000
Russia	62,250	82,000	90,000

Even before the present war Germany could not obtain copper from any of the great producing centres without the expenditure of foreign currency, though there may have been less difficulty in the case of Chile in view of the close trade relationships developed by Germany in the South American republics within the last six years. In all the other cases, however, the expenditure of foreign currency would be obligatory, and it is an interesting commentary on the need of copper that even under those conditions Germany increased her imports of copper from 127,549 tons in 1936 to 272,400 tons in 1938.

It is an admitted fact that there has been a marked scarcity of copper in Germany for some years past and very strong efforts have been made to avoid the use of copper for non-essential purposes and also to substitute cheaper and more readily available substances such as zinc and zinc alloys. Even before the war confusion was caused in the German industry when the use of zinc was recommended instead of copper and at the same time instructions were issued to use zinc very sparingly. A notable example of the use of substitutes for copper was made public in describing how two new German plastics, known as "mipolam" and "astralon" were used in the spring house equipment of the Spa at Neuenahr. The spring waters have a certain corrosive action and some of them are pumped from the earth at temperatures up to 62° C., and it was formerly believed that only copper pipes would resist the corrosive action at these temperatures. In the new equipment, however, the plastics were used for pipes and it is claimed that "mipolam" will resist temperatures up to 80° C. without softening. It has been disclosed that "astralon" production involves the use of coal and calcium carbonate as bases.

Sources of Supply in Normal Times

In view of these facts and of the largely increased amount of copper imported into the country there can only be one of two explanations, either that the demands of the armament industry have suddenly become colossal or, and more probably, that quite extensive stocking of the metal has been taking place. There are three ways in which Germany supplied her demands in normal times—first by importing metal, usually crude blister copper, secondly by importing ores, mainly cupriforous pyrites, and lastly from ores mined internally. An abstract of the statistics of the German copper supplies is given as follows by the current issue of the American hand-book *Mineral Industry*:—

GERMAN COPPER STATISTICS IN METRIC TONS.

	1934.	1935.	1936.	1937.	1938.
Total metal imports	180,247	153,365	127,549	169,920	272,400
Belgium			3,395	5,314	5,932
Yugoslavia			13,300	11,527	7,011
Rhodesia			39,124	52,001	76,503
Belgian Congo			27,807	29,608	39,931

	1934.	1935.	1936.	1937.	1938.
U.S.A.	49,643	16,588	6,568	23,935	62,330
Canada			1,524	6,414	18,995
Chile			18,994	19,620	40,006
Total ore imports	324,921	400,538	482,471	555,577	653,930
France			65,404	86,227	155,869
Netherlands			115,864	131,236	114,287
Belgium			62,902	66,752	53,710
Denmark			63,268	48,804	50,288
Norway			14,860	31,324	36,077
Domestic ore output	1,009,711	—	1,261,374	1,245,001	—
Metal content of above	28,000	—	29,800	32,800	—
Smelter output	52,600	56,700	59,000	60,000	—
Refinery output	170,600	190,439	209,600	225,900	242,700

Smelting of [Internally] Produced and Foreign Ores

The internally produced ores are the low-grade Mansfeld shales and those mines can only be operated with the aid of a Government subsidy. The grade of the ore is only about 2½ per cent. copper and the total metal production, even under the present increased production, is only 32,000 tons or scarcely 19 per cent. of the total of imported metal. In normal times, however, the employment of the 13,000 men in the mines was probably considered as a useful return on the subsidy. The imported ores are cupriferous pyrites, obtained largely in Norway and Spain, together with burned pyrites. The cupriferous pyrites serve a double purpose, in that they are burned in kilns for the production of sulphur dioxide, which is manufactured into sulphuric acid and oleum, both of which are essential for the high-explosive industry, while the residues, along with the internally produced ores, are treated in smelters for the recovery of the copper. These imported ores are also low-grade as can be seen by taking the figures for 1937. In that year the metal content of the internally produced ores was 32,000 tons while the total smelter output was about 60,000 tons, so that the copper content of the 555,000 tons of imported ores was only about 28,000 tons or an average copper content of about 5 per cent.

Imported Supplies in War

If we now examine the question of what supplies of imported metal or ore will still be available to Germany under the present conditions, it will be seen that, on account of the action of the British Contraband Control, supplies of metal will have been suspended from Rhodesia, Canada, Chile, Belgian Congo, and the U.S.A. In 1938, out of a total import of 272,400 tons, these sources supplied 235,000 tons or over 86 per cent. As to imports of ores, the two largest sources of supplies in Europe are Spain and Norway; from the latter certain supplies will still be available but the Spanish supplies will have been lost. Supplies of other low-grade ores from France have likewise been lost. As has been noted, however, the most serious loss is that of the metal imports, the total supply furnished by the smelters in Germany being only about 25 per cent. of the total production from the refineries, so that even if all the ore supplies were still available a deficiency of about 75 per cent. would remain.

The existence of quite considerable stocks of copper in Germany must be regarded as almost a certainty. If 1935 and 1936 be taken as approximating to the requirements annually, the average amount of metal imported was about 140,000 tons per year, which together with approximately 60,000 tons of metal produced from the smelters gives 200,000 tons consumption annually. As a result of the increased scale of imports during 1937 and 1938, 442,000 tons of copper entered the country. Allowing for the rate of consumption just calculated, this will result in a stock of about 160,000 tons of metal above the usual requirements, a figure which was probably much augmented during the first eight months of 1939.

With regard to the territory now incorporated in Germany, it can safely be said that the internal production of copper

will be only a fraction of war-time requirements. It was reported last year that the Mitterberg copper mine in Austria was to be reopened, and also that another old mine on the right bank of the Salzach near Bischofshofen was also reopening. In May, 1938, it was understood from Czechoslovakia that the Krompachy copper mines at Nizny Slovensky (Spis district) were being reopened and that an old electrolytic copper plant formerly used at Mitterberg in Austria was being reconstructed and modernised at the Krompachy mines and that it was to be in operation in June, 1938. Mining was started in March, 1938, and 700 men were employed. It was estimated that the production of the plant would become almost equal to the total Czechoslovakian consumption, about 25,000 to 30,000 tons annually. From Poland, the Silesian-American Corporation reported that their subsidiary company, The Giesche Spolka Akcyjna had been conducted at a loss of 998,026 zlotys for the year ended March 31, 1938. It would not appear that in any of the annexed territories will Germany find the large amounts of copper she will require for the prosecution of a long war, and in fact the supplying of the industries in those regions may be a liability in this respect.

Possible External Supplies in Europe and Asia

There are fairly large and well-equipped copper mines and smelters in Yugoslavia and these are in process of extension, but transport to Germany will present the usual problems associated with the Balkans and even if the total production were made available Germany's supplies would only be augmented by about 40,000 tons annually. The Russian copper mines are located in two centres, the Kazakstan mines at Qungrad, south of the Aral Sea, and the Balkash ores near the northern shores of Lake Balkash. During 1937 the estimated copper consumption in Russia was 140,000 tons and the total smelter output less than 90,000 tons, while the imports into Russia were 64,765 tons. In view of these facts it is highly unlikely that much of the copper from the Russian deposits will find its way to Germany. The necessity for shipping the material through the Black Sea and the Mediterranean will also restrict any extensive transfer even if such were contemplated.

It is scarcely to be wondered that, in a recent issue of the *Frankfurter Zeitung*, there appeared an article showing how much the production of zinc had increased since the conquest of Poland and urging the adoption of zinc and its substitution for as many purposes as possible for which copper had formerly been employed. If the forecast of a three-years' war materialises then Germany's position in regard to copper supplies will be a very precarious one long before that period of time has elapsed.

OFFICERS OF INSTITUTE OF METALS FOR 1940

At a recent formal general meeting of the Institute of Metals the following nominations were made to fill vacancies occurring on the Council next year: As President, Lieut.-Colonel the Hon. R. M. Preston, D.S.O., managing director of Rio Tinto Co., Ltd. As Vice-Presidents, Dr. S. F. Dorey, chief engineer, surveyor for Lloyds Register of Shipping; Eng. Vice-Admiral Sir George Preece, K.C.B., Engineer-in-Chief of the Fleet; Mr. A. Y. G. Smout, chairman of metal group companies of Imperial Chemical Industries, Ltd. As Honorary Treasurer, Lieut.-General Sir J. Ronald E. Charles, K.C.B., C.M.G., D.S.O., director of British Aluminium Co., Ltd. As Member of Council, Dr. W. E. Alkins, research manager of Thomas Bolton and Sons, Ltd.; Mr. G. L. Bailey, M.Sc., chief officer, development department, British Non-ferrous Metals Research Association; Mr. F. C. Braby, M.C., B.Sc., director and London general manager, Frederick Braby and Co., Ltd.; Colonel P. G. J. Gueterbock, D.S.O., M.C., T.D., M.A., managing director, Capper Pass and Son, Ltd.; Dr. D. Hanson, Professor of Metallurgy, University of Birmingham.

Current Topics

Metallurgy in Ancient Britain

BRITAIN has always been to the fore in the development and use of metals. In fact, a considerable metal culture was in existence in this country when the Romans first landed. This, with other interesting facts about the history of metals, was explained by Mr. A. Pinkerton when he was inducted president of the Birmingham Metallurgical Society recently. Under the title of "Metals in the Service of Mankind," his presidential address traced the development of metals by man from their first known use in 5000 B.C. down to the present day. He pointed out that once a beginning was made, the employment of metals was quickly extended. Even in ancient Egypt they were used for a number of architectural and domestic purposes, as well as for tools and weapons of war. The search for ores no doubt proved a great incentive to exploration, and this in turn carried the knowledge of metals further afield. A curious use of iron in ancient Britain was in the form of currency bars, described as resembling partly-finished swords and consisting of a flat slightly tapering blade with blunt edges. Mr. Pinkerton added that the discovery of metals had little effect at first on the everyday life of the community, as gold, silver and even copper were used for ornamental and decorative purposes long before they were put to any useful employment. Once the elementary arts of metallurgy were discovered, and plentiful supplies of the useful ores were found, metals became fairly plentiful and were put to an ever-increasing number of uses. To-day there was hardly a phase of man's life in which metals did not play an important part.

Zinc and Lead from Australia

THE Electrolytic Zinc Company of Australasia, Ltd., and Broken Hill Associated Smelters Pty., Ltd., have entered into contracts for the supply of zinc and lead to the British Government for the period of the war and three months after. Both companies have issued statements that the contracts have been made with the approval of the Commonwealth Government. Electrolytic Zinc announced that, subject to the option of the British Government of terminating the contract when deliveries aggregated 36,000 tons of zinc, it had contracted to sell 3,000 tons of refined zinc a calendar month f.o.b. Risdon (Tasmania), at £18 15s. Australian currency a ton, plus the usual premium which refined zinc carries over and above g.o.b. (good ordinary brand) spelter. The price is subject to adjustment at half-yearly intervals in accordance with specified rises and falls in producing costs. Broken Hill Associated Smelters Pty., Ltd., acting for itself and its shareholding companies, which supply the lead concentrate for smelting—North Broken Hill, Ltd., Broken Hill South, Ltd., and Zinc Corporation, Ltd.—announced that, subject to the option of the British Government of terminating the contract when deliveries aggregated 166,000 tons of lead, it had contracted to sell 13,875 tons of lead a calendar month, f.o.b. Port Pirie, at £18 16s. 7d. Australian currency a ton. This price is subject to adjustment at half-yearly intervals in accordance with specified rises or falls in producing costs. In the year ended June 30 last, Electrolytic Zinc Company refined 69,825 tons of zinc. Allowing for an Australian consumption of zinc of about 30,000 tons annually, the quantity which the company has contracted to sell to the British Government represents approximately the whole of the

exportable surplus. Broken Hill Associated Smelters produced 182,214 tons of lead in the year ended December 31 last.

Sheffield and Essen

IN a special article published last Monday, *The Times* makes some interesting comparisons between the steel production of Sheffield and that of Essen. Thanks very largely to the loyal and enthusiastic efforts of the workers in the Sheffield forges and engineering shops, not one of whom has refused to put in extra hours of work when employers have had to ask for them, the output of armour plating, heat-resisting steels, shells, bombs, fuses and precision parts of the highest accuracy "leaves Essen aggrievedly bemoaning her one-time world supremacy." Germany, moreover, has lost more than practical priority. Sheffield University has captured the theoretical crown. The Sir Robert Hadfield Laboratories have placed the university in the van of metallurgical research. Much of its work is on light steels, and it has a certain pity for the pilots of German aeroplanes, whose inferiority it attributes to the poor quality of steel used, arising from lack of alloys. A large industrial concern, which also contributes to research, is guarding against just such an error, and has made secret and surprising provision for its supply of molybdenum and other metals. It is worth noting that control—that presumably necessary evil—had not here the disruptive influence it exerted for a while in other trades. Under the Iron and Steel Federation the industry had voluntarily accepted a form of control, and such chafing as has occurred at tardy delivery of materials has arisen not from lack of organisation but because it had so much suddenly thrust upon it. Except for certain special steels there is no bulk shortage, although here and there a firm may run short because of distribution difficulties. Transport is no easy matter; the traffic is terrific and suffers from petrol rationing and the diversion to the railways of goods normally shipped down the coast.

West Australian Iron Ore

IN view of the statement made last month by Col. Llewellyn, Parliamentary Secretary, Ministry of Supply, concerning the Government's purchases of ores from the Dominions, news of the fresh development of iron ore deposits in Australia is especially interesting. Dr. W. G. Woolnough, geological adviser to the Commonwealth Government, on his return to Perth recently, made a very favourable comment on the iron ore deposits at Yampi Sound, Western Australia, which he had just inspected. By mutual arrangement between the Commonwealth Government, the State Government and the Yampi Sound Mining Co., complete tests were being carried out on Koolan Island, the site of the major iron ore deposits in Yampi Sound area, said Dr. Woolnough. So far the tests had involved a complete geological survey of the whole Yampi Sound area, based on aerial photographs taken by the R.A.F. some time ago. The next step necessary was to verify the continuity of the ore bodies underground and to determine their quality. This had been determined by the collection of very extensive samples of iron ore. The underground extension of the ore bodies was being investigated by means of a series of tunnels, but it was almost impossible to predict the duration of the examination.

Nickel Carbonyl for Nickel Metal

A Novel and Efficient Substitute

THE employment of nickel carbonyl in the production of nickel metal from nickel-copper matte in the well-known Mond nickel process is a technique of some years' standing. A process for producing nickel from the carbonyl, differing in some respects from the Mond method, is protected in German Patent 618,108 in the names of the I.G. Farbenindustrie A.G., L. Schlecht and M. Naumann.

According to P. Assman and L. Schlecht in *Metallwirtschaft*, 1939, 22, p. 467, it is now possible to cover a considerable part of the German nickel requirements by using nickel carbonyl $\text{Ni}(\text{CO})_4$ in powder form instead of nickel metal for obtaining pure nickel, various nickel alloys, etc. The use of the carbonyl for such purposes as nickel-chromium alloys, special brasses and bronzes with a nickel content, copper-nickel alloys, and nickeliferous aluminium, is said to be much cheaper than using nickel metal for such purposes, and the products are claimed to be at least equally satisfactory.

The many-sided uses of nickel metal in the metallurgical industry are sufficiently known, but the use of nickel carbonyl as a substitute for nickel metal appears to be novel and some particulars of the method of its employment may be of interest.

In the first place, the use of nickel in the form of its carbonyl caused difficulty, principally because of the material being in powder form, but these early difficulties have been overcome. For obtaining pure nickel from the carbonyl, it is usual to employ either a coke-fired crucible furnace or a coreless induction furnace of about 600 kg. capacity. In the latter type of furnace, it is recommended to add a certain amount of nickel scrap to the carbonyl powder and to melt this mixture under a good covering of sand or powdered glass, and then to introduce further quantities of the carbonyl under the liquid slag until the full charge is reached. The molten charge is then deoxidised and desulphurised by manganese and magnesium additions in quantities of about 50 gm. each to each 100 kg. of nickel.

The principal function of the manganese is deoxidation, and of the magnesium desulphurising, the nickel. Naturally, the nickel carbonyl decomposes in the furnace to form nickel metal and carbon monoxide gas, and while the latter escapes from the metal bath, it is said that this escape is not so rapid as to be violent. When the nickel produced is required to take a high polish, it is important that the sulphur content be very low, and the nickel obtained from the nickel carbonyl powder lower in sulphur content than the usual trade nickels. As is generally known, the melting and pouring of pure nickel requires good personal experience and care, and the same applies to the use of carbonyl powder. The nickel carbonyl powder can be sintered without melting by heating it to a temperature of 1000-1200° C. and in this way sinter-blocks of high purity which can be rolled and smithed are obtainable. In this case, of course, the nickel carbonyl becomes reduced to metal in the sintering operation.

In the production of iron-free nickel-chromium alloy (80 per cent. nickel, 20 per cent. chromium) there was some difficulty in the beginning in using the carbonyl powder instead of metal, but this difficulty is avoided in the following method, using a coreless induction furnace with an acid lining. For the first melt a mixture of nickel scrap and carbonyl powder is employed, with a good covering of powdered glass. After the charge and slag are melted, a fresh supply of the carbonyl is added to the melt and the slag is changed. This process is repeated until the desired quantity of nickel is obtained. The first deoxidation is made by a manganese addition in the form of a nickel-manganese alloy, or if some iron is permissible in the alloy being produced, high-grade ferromanganese may be used. The slag is then removed, and chromium, pre-heated to redness, is added to the melt. A new lot of slag-producing material is added and the rest of the manganese alloy, and, if desired, other alloying constituents, can be added. Magnesium in the form of nickel-

magnesium is added in small quantities, usually up to 0.15-0.20 per cent. of magnesium, for desulphurising.

For producing copper-nickel alloys by the use of carbonyl powder, the melting procedure is the same as in the production of pure nickel, but for continuous operation a low frequency furnace is used. In this case the addition of the nickel carbonyl powder to the furnace is said to be simple. The addition of small percentages of nickel in the form of carbonyl powder to aluminium is said to present no difficulty; the usual addition is the equivalent of about 2 per cent. nickel.

The authors state that in all cases in which nickel carbonyl has been used to replace nickel metal, the products in no sense have been inferior to those made by the use of nickel metal. Moreover, the average higher purity, and particularly the very low sulphur and freedom from hydrogen, are advantages compared with trade nickel metal.

Manganese Ore in the U.S.A.

Production, Imports and Stocks

DOMESTIC production in the U.S.A. of manganese ore containing 35 per cent. or more manganese (natural) during November, 1939, was 4,490 long tons, shipments were 4,100 tons, and producers' stocks at the end of the month were 1,800 tons, according to the Bureau of Mines, United States Department of the Interior. In October, production and shipments were 3,400 and 3,200 tons respectively, and producers' stocks at the end of the month were 1,600 tons. The rate of shipments during November was considerably more than the monthly average of 2,110 tons in 1938, when the total amounted to 25,321 tons.

According to data supplied by the Bureau of Foreign and Domestic Commerce, November imports for consumption of manganese ore containing 35 per cent. or more manganese were 53,855 long tons containing 26,811 tons of manganese. Of the imports in November, the Gold Coast supplied 42 per cent., Cuba 23 per cent., the U.S.S.R. 18 per cent., Brazil 9 per cent., and British India 8 per cent. General imports amounted to 55,844 long tons containing 26,851 tons of manganese in November, of which Gold Coast supplied 27 per cent., Cuba 22 per cent., Brazil 21 per cent., British India 20 per cent., and the Union of South Africa 10 per cent. All the above ore contained more than 35 per cent. manganese; there were no receipts of ore containing 10 to 35 per cent. manganese in November. For the first eleven months of 1939, general imports of ore containing 35 per cent. or more manganese were 583,148.

Stocks of manganese ore in bonded warehouses on November 30 amounted to 887,720 long tons containing 437,323 tons of manganese compared with 842,048 tons containing 418,721 tons of manganese at the beginning of 1939.

STEEL TUBES FOR WATER WELL CASING

At the request of the War Office, and with the full co-operation of the Water Well Drillers' Association, the British Standards Institution has recently issued a British Standard for Steel Tubes for Water Well Casing (B.S. 879-1939).

The specification applies to lapwelded and weldless tubes of nominal diameters from 4 in. to 48 in. with two types of screwed joints, namely, screwed and socketed (with V or square form threads) and with flush joints inside and out with square-form threads. The quality of the steel is determined by tensile bend and flattening tests, while flattening tests are also included to determine the quality of the weld. Hydraulic test pressures are prescribed, and general requirements are included in respect of the accuracy of the alignment of joints, of coating and oiling of tubes, and of packing for transport. Fully detailed requirements are given for the dimensions of the tubes and sockets and their screw threads.

Copies of the new specification may be had from the British Standards Institution, 28 Victoria Street, London, S.W.1, price 2s. 2d. post free.

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Metallurgical Section

March 2, 1940

PIG-IRON MANUFACTURE IN AMERICA*

Iron Ore and its Transport

BY far the greater part of American pig iron—about 80 per cent, of the total in a normal year—is manufactured in a region which depends for its raw materials upon the Central Appalachian coal fields and the iron ore deposits of Northern Michigan, Wisconsin and Minnesota. Herein are found not only the great producing centres of Pittsburgh and Chicago, with their super-plants of Homestead and Gary, but also the districts of Cleveland, Buffalo, Detroit and the Ohio River Valley, in each of which are plants the annual productive capacity of which is measured in millions of tons. The region may be defined as that encircled by the Alleghany Mountains, the Great Lakes, and by the Ohio and the Mississippi rivers. In this mid-western area have been felt the full effects of the unusual combination of economic, geographical and metallurgical conditions which American methods of pig-iron manufacture and the American type of blast-furnace have been developed to meet.

Some of the plants in this region are situated very close either to the middle Appalachian coal fields or to the Lake Superior ore deposits. At the one extremity will be found Johnstown, Pennsylvania, where the Cambria plant of the Bethlehem Steel Company is located, literally on top of the coal, and at the other, a thousand miles away, Duluth, which is, figuratively at least, on top of the ore. The freight charges on coal at Johnstown are negligible, but on ore amount to approximately \$6.00 per ton of pig iron, while at Duluth freight charges on ore are only \$1.75 but on the coal about \$4.25 per ton of pig iron. The transportation charges on ore and coal combined, therefore, are about the same in both cases.

Plants between these points are situated alongside or near water-courses, principally the Ohio River and its tributaries or one or another of the Great Lakes, from which is derived relatively cheap transportation for either ore or coal or for both. These geographical features do not completely determine the desirability of the location for pig iron manufacture, since the cost and availability of scrap suitable for blast-furnace use and the proximity of the producing plants to the markets for pig iron and for blast-furnace by-products are other determining factors. But since all the plants of the Mid-West have had the same or very similar raw materials, the constructional features and manufacturing methods of the entire industry in this district have been largely determined by the nature of these materials and the problems

incident to their mining, beneficiating, transporting and smelting.

From a chemical-analysis standpoint the Lake Superior ore fields have provided a sufficient variety of ore for the manufacture of all the principal foundry and steelmaking grades of pig iron, but not ferro-alloys. A few mines in the Cuyuna range can supply ores with manganese contents of from 5 to 10 per cent., and two of them with more than 15 per cent. of manganese, but the shipments of these are relatively small. These are used only for the regulation of the manganese content in the ordinary grades of pig iron. There is some

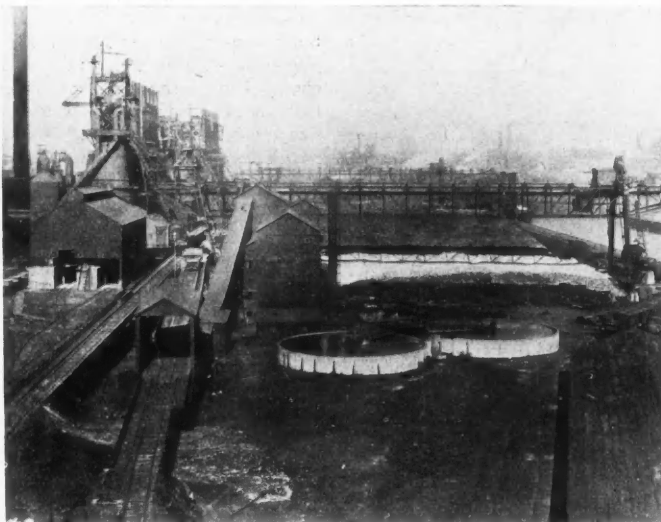
manganese ore produced in Southern and Western States, but American requirements of these materials have in ordinary times been imported overseas.

There is also a scarcity in the Lake Superior fields of extremely low-phosphorus grades, such as are held in such high esteem in England for the production of hematite iron. Only one or two mines can ship ore of less than 0.015 per cent. phosphorus content. It should be remembered, however, that the output of hematite pig in America is very small. Scarcely any acid open-hearth steel is produced except for the manufacture of steel castings. The acid open-hearth steel production in the States is about 1 per cent. of the

total, as compared with almost 20 per cent. in the United Kingdom. There are, however, sources of very low-phosphorus ores, such as some of the New York State magnetites previously referred to, which could be more extensively developed if need be.

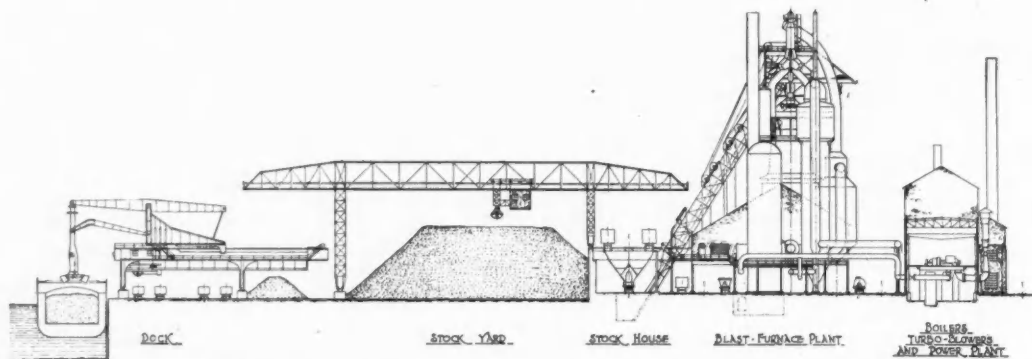
The great bulk of the Lake Superior ores is, however, eminently satisfactory for the manufacture of foundry pig iron and of pig for use in making steel by the acid Bessemer or basic open-hearth methods, which, in America, represent more than 90 per cent. of the total. The Bessemer pig iron output in 1937 was 16 per cent., basic 66 per cent. and foundry, including malleable, 13 per cent. of the total. The remaining 7 per cent. was classified as low phosphorus. No iron, strictly speaking, of basic Bessemer grade was made. The ores of Newfoundland and Alabama are near-basic-Bessemer quality, but pig iron made from them in America is all converted by the basic open-hearth process.

As to iron content, although the average is declining each year, very little ore is shipped from the Lake Superior ranges that has less than 50 per cent. of iron in the natural state except the manganiferous and so-called siliceous grades, the latter constituting only about 3.5 per cent. and 1.9 per cent. of the total. Bessemer ores were 20.2 per cent., basic ores



[By courtesy of the Republic Steel Corporation.]
Plant with four blast furnaces in Cleveland, Ohio, district. Facilities for unloading from lake carriers and transferring raw materials from stock piles to the blast-furnace stock trestle are shown: in foreground flue dust recovery and sintering plants.

* From a paper presented by William A. Haven, of Cleveland, Ohio, U.S.A., to the Iron and Steel Institute.



Elevation of a typical blast-furnace plant located on a water-front.

70 per cent., and high-phosphorus foundry ores 4.4 per cent. of the total shipments, and the average iron contents of these were 54.66 per cent., 51.44 per cent. and 51.94 per cent., respectively.

The Lake Superior ores are surprisingly free from minerals obnoxious or detrimental to smelting, such as lead, zinc, titanium, and arsenic. Their sulphur content, for the most part, is too low to be a serious problem. The gangue-forming elements are chiefly silica and alumina, generally in proportions to form a blast-furnace slag of satisfactory analysis. Washing operations, however, have had a tendency to disturb the silica-alumina balance in certain ores, and means to keep this relationship in the slag at the desired figure of about 32:15 form one of the current problems of American practice.

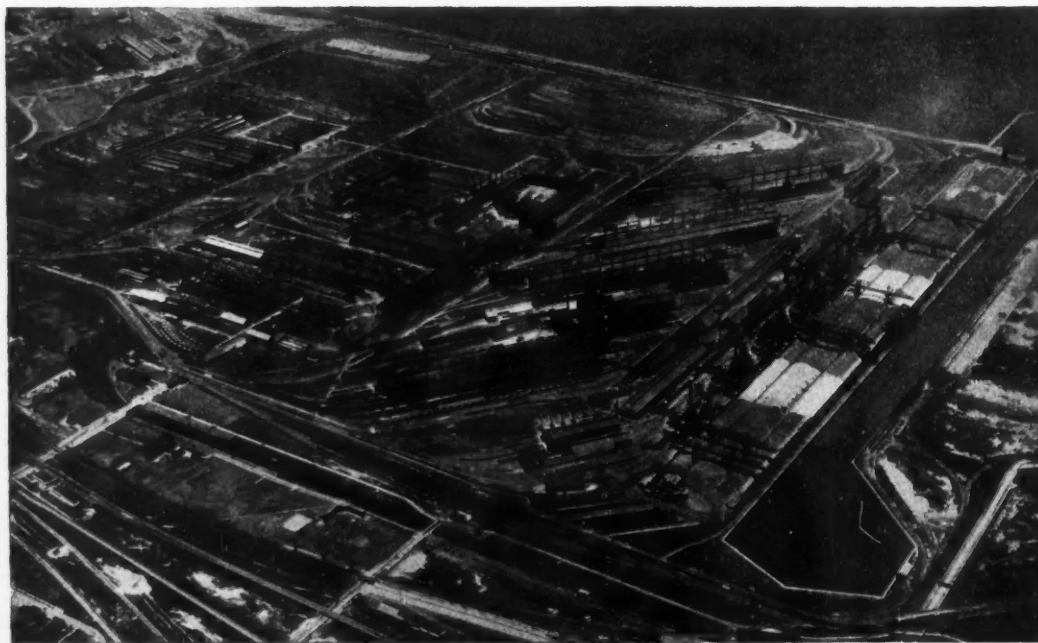
In addition to their richness and, generally, their all-round satisfactory chemical qualities, the Lake ores have the further advantage of being easily reducible. Mineralogically, they are practically all hematite, or mixed hematites and limonites, red, yellow, brown or blue in colour, soft and reasonably porous. Silicates of iron and other refractory minerals are not commonly found in any objectionable amounts, although these were among the constituents of the original iron formation, geologically speaking, from which the present commer-

cial ore deposits were derived by leaching and oxidation. A few of the ores, particularly in the Marquette and Vermilion ranges, are hard and dense, apparently rendered so by the pressure and heat of igneous intrusions and by regional deformation of the iron-bearing rocks. These ores are especially well suited for use in the making of steel by the basic open-hearth process.

For the most part, however, the Lake ores are found in much the same earthy condition as they remained after the oxidation of the iron and the leaching of silica from the cherty iron formations, being compressed in slumping by little more than their own weight. Thus they occur in particle sizes that range from that of ordinary gravel to the finest powder.

Transportation of raw materials for blast-furnaces on the Great Lakes is one of the most interesting features of the American industry. The average amount of Lake ore shipments over the past twenty-five years has been, in round figures, about 50,000,000 tons annually, but statistical data for 1937, although based on total shipments of about 63,000,000 tons, are more satisfactory for the purpose of comparisons. There are six upper lake ports equipped for shipping and sixteen lower lake ports equipped for receiving ore.

The Lake vessels employed are little more than self-pro-



[By courtesy of Carnegie-Illinois Steel Corporation.]

Aerial view of Gary works; includes the world's largest pig-iron producing plant. Twelve modern blast-furnaces. Typical American arrangement for lake-front plant, with docks, fast unloaders, reserve stock piles for ore and limestone, stocking and reclaiming bridges.

pelled barges, with the pilot-house and officers' quarters forward, the boilers and engine room in the extreme after portion. The cargo hold occupies all the space between these, a compartment several hundred feet long, which is clear of intervening structure or equipment except bulkheads that extend from the bottom to the hatch deck at about 100-ft. intervals. After loading there is frequently less than 10 ft. of freeboard amidships, and there is no superstructure over the hatches, which are spaced only 12 ft. apart. During heavy seas, the entire length of the deck, between the pilot house and engine room, is sometimes awash, and passageway from one end to the other is cut off except by breeches-buoy.

Seaworthiness in the Lake carriers has been exchanged to a considerable extent for advantages in other respects, as the first considerations in the design of the Lake carriers has been the economical transportation and handling of ore and coal, and the rapid loading and unloading. The most recently built and largest carriers, turbine-powered, are about 600 ft. long, and will carry over 15,000 gross tons. Speed is generally at an optimum economic rate of about 12 miles per hour. The draught of the vessels is limited by the water levels in Sault Ste. Marie Canal and certain rivers through which they must also pass.

Blast-furnace Practice

As regards blast-furnace practice, the most important advances in the last half-dozen years have probably been in the preparation of raw materials. Methods of blast-furnace operation have become more uniform as a result of crushing all ores to smaller sizes and the adoption in other districts of furnace lines and equipment that has been developed particularly for economical smelting of the fine Lake Superior iron ores. All new furnaces built since 1933 have been of the 1,000-ton class and the rebuilding of old stacks to larger sizes has continued. This procedure has been justified not only by increased output per stack and consequent reductions in the "cost above raw materials," but by markedly improved results metallurgically. Coke consumption rates have been lowered, flue dust losses have been curtailed, and pig iron quality has been improved in analysis and uniformity. The larger furnaces have also, as is now well known, shown a remarkable flexibility for satisfactory operation over a wide range of daily output. The annual production of pig iron rose from 13 million gross tons in 1933 to 36 million in 1937, while the production of ferro alloys increased from 344,833 tons to 997,681 in the same period.

Hard-Facing Tools and Dies

Preliminary Cleaning Essential

GRATIFYING results have been obtained by hard-facing dies and parts of machinery subject to excessive wear at the plant of a large manufacturer of calcium carbide. Hard-faced shear blades, drill bits, knives, heavy-duty hooks, and dies of all kinds are used in the production of steel drums.

One particularly successful application is the hard-facing of a double seamer head which is part of a drum-making automatic double seamer. This hard-faced head was in continuous service for over a year and during that period completed the double seams on both the tops and bottoms of 415,557 100 lb. drums. The head is made of mild steel with wear-resistant alloy applied to the wearing or seaming edge. The cost of making up this head, including all labour and material, was approximately £3. Previously these heads were made of various grades of tool steel at a cost of approximately £2 14s. each, including labour and material, and lasted, on an average, from three to four months. The tool steel heads, when worn below standard, were discarded and replaced with new ones. The hard-faced head, however, has been reconditioned by applying more wear-resistant alloy, and regrinding to standard gauge at a cost of about £2. It has been put back into service and, in fact, is just as serviceable as a new head.

Though the actual economies of hard-facing this particular

part may seem small, the time saved through less frequent renewal of parts and fewer interruptions of production, a fact proved in so many instances where even small amounts of alloy are applied to wearing parts, is quite considerable. Other parts that have been successfully hard-faced at this plant include gauges for edging shears, corrugated rolls, grooving dies, drum-burring wheels, side-seaming wheels, and top threading dies for 100 lb. drums.

Before applying the hard-facing material, the wearing parts are carefully cleaned by machining or grinding the surfaces to be hard-faced, giving them as smooth a finish as possible. All this work on the surfaces of the parts is done very carefully, leaving no thin, sharp corners and providing fillets if the hard-facing material is to be deposited in grooves. In applying the hard-facing alloy to steel, a blowpipe flame with an excess of acetylene is used. The surface of the base metal is then heated to a sweating heat and the hard-facing alloy is flowed on. Following the application of this material, the part can be ground to the correct size by using suitable grinding wheels.

Production of Pure Titanium

Electrolysis and Solvent Processes Examined

INVESTIGATION of the metallurgical properties of titanium by the U.S. Bureau of Mines has been limited during the past year to a survey of methods of preparing pure titanium, according to the Bureau of Mines Investigation Report, 3480 (January, 1940). The extreme stability of naturally occurring compounds of titanium and the extreme reactivity of the metal even at fairly low temperatures make preparation of pure titanium difficult. Many attempts have been made to produce titanium by electrolytic methods. Several of these, the subject of conflicting reports in the literature, were investigated. A discussion of the methods employed to-day is not inappropriate, as this year marks the centenary of the birth of Nilson, the chemist who first succeeded in producing titanium metal 95 per cent. pure (see THE CHEMICAL AGE, p. 111, this issue).

Because of the greater simplicity and lower cost, electrolysis of various aqueous solutions was tried first. Solutions of chlorides and sulphates, as well as some containing organic anions, were tried over a range of pH and concentration and with iron, copper, lead, mercury, and titanium cathodes. All results indicated deposition of hydrogen rather than titanium. Attempts to produce an amalgam of titanium were unsuccessful. Co-deposition of iron and titanium was obtained from suitable solutions, but could not be developed practically.

The following fused salt electrolytes have been investigated on a small scale: (1) Mixtures of sodium and potassium fluotitanate with and without added titanium dioxide; (2) Mixtures of sodium and potassium fluoride with titanium dioxide in solution; (3) Bauxite mixtures similar to those used in the production of aluminium by electrolysis. In (1) volatilisation loss was prohibitive, and no titanium was deposited. In (2) a compound rather than titanium metal was deposited. Work on baths of type (3) has not been completed.

In the field of displacement processes, reduction with carbon and hydrogen was tried first because of the low cost of these materials. Results confirm the view that a pure titanium cannot be made by reduction with carbon. Hydrogen will not reduce titanium oxide at temperatures below 1,300° C.

Magnesium, manganese, and sodium do not displace metallic titanium from its oxide; aluminium, by the Goldschmidt process, displaces titanium from its oxide. The reaction takes place at a very high temperature and the product is not pure, because of contamination both from the container, from the atmosphere and from the excess of aluminium required to effect complete reduction. Metallic sodium, heated with titanium sulphide in a hydrogen atmosphere to dull red heat, reacts with a pronounced absorption of hydrogen. A considerable proportion of a water-soluble sulphide is formed also. This reaction is being investigated as a possible source of titanium hydride.

Current Topics

Magnesia from Canadian Brucite

ACCORDING to *Canadian Chemistry and Process Industries* (24, 1, 3), research work conducted by the Bureau of Mines at Ottawa on the recently-discovered deposits of brucite in Ontario and Quebec is likely to lead to Canada's independence from foreign sources of high-grade refractory materials, such as are essential for use in the steel and other metallurgical industries. Commercial deposits of brucite, a magnesium hydroxide, were first discovered in Canada in 1937 at Rutherglen in the Nipissing District of Ontario by Mr. M. F. Goudge, of the Federal Bureau of Mines. Subsequent field work by him has disclosed other deposits in the same area and in the Bryson and Wakefield areas in Quebec. All the deposits are within easy reach of transportation. The brucite occurs as small crystals or grains in crystalline limestone and comprises about 25 per cent. to 30 per cent. of the rock. A process involving the successive steps of calcination, hydration, and separation of brucite from lime, has been developed by the Bureau at Ottawa whereby pure magnesia can be obtained, apparently at a cost which will enable it to compete in Eastern Canada with magnesia at present being imported. An analysis of a typical sample of calcined brucite granules gave 94.40 per cent. magnesia, with 4.38 per cent. water, 0.50 per cent. SiO_2 , 0.59 per cent. Fe_2O_3 , 0.38 per cent. Al_2O_3 and 0.40 per cent. CaO . Magnesia so obtained appears to be highly suitable for the manufacture of basic refractories, for the making of magnesium salts, etc. Special significance is attached to the discovery and to the development of the process, since magnesia of equal purity has not hitherto been available from any Canadian source, but has had to be imported. Supplies of magnesia for Canada have hitherto been obtained mainly from the Western United States, Europe and Asia. In his report* issued late in 1939 Mr. Goudge describes in detail all the known deposits of brucite in Ontario and Quebec and the methods of separating magnesia from the deposits.

Vermiculite Recovery in S. Africa

AN examination of the vermiculite deposits around Palaboroa, N.E. Transvaal, has led to the adoption of methods of dressing the raw material somewhat different from the usual practice followed in America. The American material normally requires merely the elimination of coarse stony material by segregation in pneumatic conveyors, followed by a dry-tabling process. With the South African vermiculite, however, these methods are not applicable because the facility of cleavage of the material appears to be much greater, and a considerable proportion of gangue of low specific gravity is often present. The recovery method recommended is to draw the ore from a receiving bin through a steam-heated rotary dryer to the screening machines. Thence it is fed to a hammer-mill or revolving-cage disintegrator and again to the screens. Undersize material is then separated from rocky ingredients and gangue flakes by winnowing through a horizontal air blast. It is easily possible to arrange the blast in such a way that the thickest reasonably clean ver-

miculite is just slightly thicker than that giving equidimensional grains after expanding. Two successive blast-winnowings facilitate the accurate elimination of undersize material. Passing the residue material mixed with gangue through further crushing-rolls causes the cracking of the gangue grains, owing to their greater brittleness, and allows nearly all the vermiculite to be recovered by rescreening.

Australian Wolfram

FINAL arrangements for war-time control of the Australian wolfram ore production, which have been under consideration for some time between the Ministry of Supply and the Australian Commonwealth Government, were ratified at a meeting in Melbourne last Tuesday. The annual production of the ore, which is of good grade, averages approximately 1,000 tons, and it is understood that it will be marketed through normal trade channels. The payment to be made will probably be on a basis of £3 2s. 6d. Australian currency per unit f.o.b. (£2 10s. English).

Scrap Metal Campaign

THE collection of scrap metal is being encouraged by a nation-wide campaign which was launched recently. The campaign is under the charge of Major H. E. Crawford, chairman of the National Federation of Scrap Iron and Steel Merchants, who announced that some 150,000 firms had been approached and as a result additional scrap had been secured that would have taken ten or twelve ships to carry if it had been imported. He added that the demand for iron and steel scrap was not a panic need. If scrap could not be found at home it could be imported, but importation was expensive and made unnecessary demands on shipping space. The campaign will embrace the ordinary householder within its scope and it is probable that "scrap weeks," during which householders will be asked to make their contributions, whether they be old iron bedsteads or ploughs, will be organised. The normal trade channels will be utilised to deal with the scrap.

THE CARBONYL PROCESS FOR NICKEL

In the Metallurgical Section of THE CHEMICAL AGE, February 3, an abstract of an article published in a German technical journal appeared under the heading "Nickel Carbonyl for Nickel Metal." The following comments on its contents have been contributed by a correspondent:—

The abstractor of the article has assumed that the end products of the process used by I. G. Farbenindustrie is the compound nickel carbonyl and that it is used in the making up of alloys, etc. Actually, just as in the Mond process, the carbonyl forms a half-way stage, being subsequently decomposed to nickel. The process used by I. G. Farbenindustrie differs from that employed by Mond in that the end product is a fine powder which gives some trouble in alloy making and the purpose of the original article was to indicate means by which such trouble could be minimised.

The second part of Dr. Howat's article on the Scarcity of Copper and Zinc in Germany, which will analyse the position regarding zinc, is held over until the publication of the April metallurgical section.

* Memorandum Series No. 75. "A Preliminary Report on Brucite Deposits in Ontario and Quebec and their Commercial Possibilities." (Available in the Reference Library, Canada House, Trafalgar Square, London, S.W.1.)

Metallurgical Section

April 6, 1940

SCARCITY OF COPPER AND ZINC IN GERMANY II.—An Analysis of the Zinc Situation

By
D. D. HOWAT, B.Sc., A.Inst.M.M., A.I.C., Ph.D.

SOME account was given in a recent article of the causes leading to an increased demand for copper in Germany and of the factors which make for the real shortage of that metal during the war (THE CHEMICAL AGE, 42, 1075, Met. Sect., 5-6). It was shown that so long as the Allied navies retain command of the seas Germany will be unable to import copper from those sources which in normal times contribute up to over 80 per cent. of the demand.

The position with regard to zinc is rather different, as there are available supplies of the metal produced from ores mined within the country. A recent article in the *Frankfurter Zeitung* sought to prove that so far as zinc is concerned Germany's situation has been considerably improved by the annexation of Polish territory. Germany, according to this article, can now rely on a zinc production of 305,000 tons a year, a figure arrived at by adding together the quantities of zinc produced in Germany and in Poland during 1938, the figure for Germany being 194,000 tons and for Poland 110,000 tons. In spite of this disclosure, rather paradoxical instructions were issued to German industrialists recommending the substitution of zinc for copper wherever possible, yet in the same breath exhorting the very sparing use of zinc, and completely forbidding its use for certain purposes. To quote an American commentator: "The purpose of these restrictions is more educational than practical. The intention appears to be to show manufacturing industries that they can get along with the reduced amount of metal available." The restrictions do not apply to the production of metal wares for export.

Zinc is one of the most widely applied of the common non-ferrous metals and the increase in its consumption is a comparatively recent development. The use of a zinc coating on other materials as a protection against rust and corrosion forms the basis of all galvanising. Millions of tons of galvanised material are produced annually in the form of sheets, pipes, structural steel and wire for wire-ropes. This industry accounts for the major portion of the world zinc consumption. Brasses, alloys of copper and zinc, play an important part in modern engineering and warfare, being used for pumps, pump-casings, valves, and cartridge-cases. A new and more recent development in the utilisation of zinc has been the production of "die-castings." These have made possible the production of metal parts at low cost in a great variety of intricate shapes, and have found a very extensive field in the motor-car and aeroplane industries. Rolled zinc sheet has also found a large application in the manufacture of dry-battery containers and as a roofing and lining material.

Zinc Roofing "Verboten"

In view of these facts it is not altogether surprising to find that the use of zinc for certain purposes has been forbidden in Germany. For example, roofs may no longer be covered with zinc sheet, slate being recommended; for receptacles, water tanks, etc., the use of enamel or resin coats is suggested, while pipes with a protective bitumen coating are to be substituted for galvanised pipes. Wherever possible all zinc available must be saved for armament purposes.

That zinc is one of the important metals in the armament

industries is shown by the following figures, which give the annual consumption in various countries:—

ZINC CONSUMPTION IN METRIC TONS.

	1936.	1937.	1938
World total	1,524,900	1,635,800	1,487,200
Germany	209,000	233,700	260,500
Japan	78,000	85,000	90,000
Russia	66,000	73,000	81,000
Britain	220,300	231,600	211,700
France	85,200	91,900	89,200
United States	520,400	557,100	374,800

The figures for Germany and Japan are interesting, in that stringent regulations in force in both countries limit or forbid the use of the metal for non-essential purposes, yet in the first the consumption has increased by 30 per cent. in three years and in the latter by over 15 per cent. It is impossible, however, not to reckon with the possibility of the accumulation of stocks in both countries. A noticeable feature of the year 1938 was the excess of metal production over indicated consumption and it has been estimated that the tonnage of zinc stocks at the end of 1938 was over 27,000 tons. For the mining of zinc ores the most important countries are—U.S.A., Canada, Germany, Newfoundland, Mexico, Australia, and Burma, while the production of zinc metal by smelting is carried out mainly in the U.S.A., Belgium, Canada, Germany, Poland, and Great Britain, very large tonnages of zinc ore being shipped to the smelting centres from various places.

The German Zinc Industry

Before the war of 1914-1918 there had been developed in Germany a zinc smelting industry which had given that country a commanding position in regard to world supplies of the metal. The existence of the rich lead-zinc deposits in Upper Silesia had been an important factor in this development, but the industry had always been dependent on large imports of foreign ore. The Zinkhüttenverband, aided by powerful financial and smelting interests, sought to control the non-ferrous markets of the world with special reference to zinc. This organisation obtained, by long-term contracts, supplies of zinc ore from all over the world, the Broken Hill deposits in New South Wales being one of the most important sources of supply. The last war broke this control and "The Non-Ferrous Metals Bill" passed by the British Parliament in 1918 sought to control the Empire supplies of zinc concentrates and prevent the control by any other country of such an important commodity. The loss of the mines and zinc smelters in that part of Upper Silesia ceded to Poland under the Versailles Treaty also considerably reduced the importance of Germany as a factor in the world's zinc supply. The ore output from the German section of Upper Silesia was smelted in the Polish smelters and the exit of the zinc concentrates from Germany and the re-entry of the metal was governed and maintained free of Customs duty by the German-Polish Agreement of May, 1922. In spite of those considerable handicaps the industry was reorganised on a large scale in order to treat internally produced and imported ores. With the aid of Government subsidies new

smelters were built, old ones reconstructed, and some new electrolytic plants put into commission. The new plant at Magdeburg treats the ore that was formerly smelted in Poland. At Oker and Duisburg new smelters were erected to supply the zinc used for galvanising in the adjacent plate and wire mills. Sulphuric acid and oleum plants were built to operate in conjunction with the smelters utilising the sulphur dioxide produced during the roasting of the ores.

The deposits in Polish Upper Silesia extend eastward from the town of Katowice, and contain an average of 16 to 18 per cent. of zinc. There are also low-grade deposits around Tarnowice. In 1938 the output of metal from the Polish smelters was 110,786 tons, but of the ore treated only 60 per cent., containing 67,000 tons of zinc, was produced in Polish Upper Silesia, the remainder being obtained from other countries, including Germany and Italy. The largest zinc company in Poland was the Giesche Spolka, a subsidiary of the American-owned Anaconda Copper Mining Company, from which the zinc output was 59,076 tons in 1938.

The present position is that Germany controls the Polish mines and smelters and, according to the *Frankfurter Zeitung's* estimate, has a total production of over 300,000 tons annually. This figure is undoubtedly the combined smelter output of the two countries but it does not take into account that in neither country could the total tonnage of ore treated in the smelters be produced from internal deposits. In the case of Poland the figure was only 60 per cent. of the total and the position in Germany is revealed by the following statistics:—

GERMAN ZINC STATISTICS IN METRIC TONS.

Year.	Production.			Imports.			Exports.		
	Ore.	Metal	Sheets.	Ore	Metal.	Sheets.	Ore.	Metal.	Sheets.
1936	139,400	136,400	72,900	120,664	72,769	5,129	18,752	154	7,974
1937	147,000	163,200	—	146,262	70,557	5,507	44,891	101	5,578
1938	—	185,300	—	185,003	74,907	6,878	47,049	6,888	5,959

ZINC METAL IMPORTS IN METRIC TONS.

	1936.		1937.		1938.	
	Ordinary.	High Grade	Ordinary.	High Grade.	Ordinary.	High Grade.
Total	59,092	13,677	59,314	11,242	58,757	16,150
Source:	72,769		70,556		74,907	
Belgium	20,519	962	15,286	—	23,144	—
Poland	25,332	1,385	28,057	186	29,425	785
Norway	5,700	10,929	2,280	7,800	1,999	13,187

The metal exported during the last three years has not been a large tonnage, so, from these figures, it would appear that the demands of the engineering industry in Germany require the import of about 70,000 tons of metal and 180,000 tons of zinc ore. The metal content of the imported ore will probably be 75,000 to 80,000 tons, so that the total imports in terms of metal are 145,000 to 150,000 tons. The smelter production in Poland was 110,786 tons in 1938, but the metal content of the ore mined in the country was only 67,000 tons. Imports of zinc into Germany from Poland were 30,000 tons in 1938, so that the net gain to Germany from the annexation of Poland will be 35,000 to 40,000 tons. Thus it would appear that the final deficit in German supplies of zinc will be about 100,000 tons of metal. Taking the 1938 figure of 260,000 tons consumption, this will represent a deficit of almost 40 per cent. This figure is considerably less than given by Mr. O. W. Roskill, who estimates the position for Greater Germany, including Austria and Czechoslovakia, as follows:—"The combined apparent consumption of zinc in Greater Germany in 1938 was probably 270,000 to 290,000 tons. During that year the imports were 74,907 metric tons of metallic zinc and 185,000 tons of zinc concentrates, equivalent to about 75,000 tons of recoverable zinc. Allowing for the inclusion of Czechoslovakia, it is reasonable to assume that, of the total consumption in 1938, at least 165,000 tons were met by imports. Assuming the maintenance of high levels of consumption of the past two years, it can be calculated that Greater Germany is in a position to supply only about 45 per cent. of its zinc requirements."

In the remaining German-controlled countries the possibility of meeting the demand for zinc supplies is very small. In Czechoslovakia there are only two small smelters, with a tonnage of 21,600 tons annually. In Austria there are no zinc smelters and the total mine production of the incorporated areas is probably less than 5,000 metric tons annually. In Germany itself various low-grade mining properties have been opened by the Stolberg and Schlesag companies but the output from these is not large.

Possible sources of supply of zinc to Germany may be found in Italy, Yugoslavia and the U.S.S.R. Sardinia is the source of nearly two-thirds of the Italian output of zinc ores. The production of zinc concentrates has increased rapidly during the past few years owing to the payment of substantial Government subsidies. Of a total production during 1938 of 201,863 tons of concentrate, with a metal content of 77,600 tons, 73,732 tons were exported. Exports to Germany were negligible but those to Belgium totalled 33,764 tons, further supplies going to France and Poland.

A recorded output of 80,000 metric tons of metal in the U.S.S.R. during 1938 has been estimated to make that country self-sufficient in zinc. The main sources of zinc ore are the Sadon district of the Central Caucasus and the Ridder deposits at Semipalatinsk in the Altai mountains. Further output of ore is also reported from the Salair deposits in Western Siberia and the Turlan deposits in Southern Kazakhstan.

The important lead-zinc-silver mines in Yugoslavia are owned by a British firm—Trepca Mines, Ltd.—which con-

trols the Stantrg, Vojetin and Dobrevno mines. The Stantrg mine, the largest and most important, is located near Mitrovica in the Kosovska district and is connected with Belgrade by 180 miles of railway. The estimated ore reserves of this mine are over 4 million tons, averaging 9.2 per cent. of lead, 5.6 per cent. of zinc, and 3.8 ozs. per ton of silver. For the year ending September 30, 1938, the production was 70,120 tons of zinc concentrate with 50 per cent. zinc. Nearly all the production is exported as there is only one small smelter at Cinkarna, but an agreement has been reached with the Yugoslav government under which the company undertakes to erect and operate, through subsidiary Yugoslav companies, a lead smelter with a capacity of 12,000 tons annually and a zinc smelter with 10,000 tons capacity.

Even if Russia had any surplus available, transport of metal or ore in large quantities from those regions of that country to Germany will be attended with all the difficulties commonly experienced under Russian control. The possibility of acquiring foreign currency from Belgium, France and Poland has apparently been a greater force in Italian exports than the support of her "Axis" partner. Yugoslavia offers the most convenient source of supply, and the existence of these large deposits affords another proof of the very difficult position in which that country finds itself in a world of "power politics."

To sum up, it may be said that while the position is not nearly so serious as in the case of copper, the maintenance of adequate supplies of zinc will present the rulers of Germany with some very difficult economic and political problems.

Nickel Electrolysis*

Deposition by Insoluble Anodes

ELECTROLYTIC winning of nickel from nickel sulphate solutions by means of insoluble anodes depends mainly on chemical control of the pH of the catholyte. If the catholyte becomes basic enough, a precipitate of nickel hydroxide or basic nickel sulphates will form in the catholyte at pH 7 to 8. On the other hand, if the catholyte becomes acid enough, hydrogen is evolved at the cathode in preference to nickel. The evolution of hydrogen becomes a major difficulty at pH 4 or under. Mr. Thompson (Trans. Am. Electrochem. Soc., 41, p. 333) has correlated the pH of nickel electroplating baths using soluble nickel anodes with the structure and physical characteristic of the deposited nickel and has found that there are definite ranges in which specific common flaws occur in nickel plate. The results, which he obtained from carefully standardised plating tests in which the pH was varied, may be summarised as follows:

1. The cathode efficiency may be increased either by raising the current density or the pH, or by raising both.
2. In the range of pH 6, or above, the current density has little or no effect on cathode efficiency.
3. Below pH 3 and up to 4, gas pits and streaks, which are usually attributed to hydrogen evolution, are very pronounced. Cracking and peeling of the deposits are generally encountered in this range. The nickel deposited is usually rather bright.
4. Between pH 5.5 and 6.5, gas pits and streaks are found only rarely. Above pH 6.3, blistering, cracking, and curling are again likely to occur, also "burning" of the deposit near sharp edges, especially with high-current densities. This is characterised by dark or black bands or patches. The nickel appears greyer in colour, verging toward bluish near the upper limit of pH. Above pH 6.3, it seems difficult to get deposits in still solutions. In agitated electrolyzing solutions good deposits may be obtained up to nearly pH 7.0.

The presence of borates in the nickel electrolyte improved the characteristics of the nickel deposit and to some extent limited the ionisation of free sulphuric acid present originally or formed in the electrolyte.

Catholyte pH Control

Several methods were tried in an attempt to control the pH of the catholyte during the course of electrolysis. Some of these were (1) rapid circulation of electrolyte, the catholyte feed to the cell being at all times saturated with and carrying in suspension nickel carbonate; (2) the introduction of alkali ion in the form of sodium sulphate, together with a somewhat slower circulation; and (3) the introduction of ammonium ion as ammonium sulphate. Keeping the catholyte feed saturated with nickel carbonate gave satisfactory nickel deposits, but this scheme was not deemed satisfactory as the use of such a method would force the precipitation of all the nickel as nickel carbonate before electrolysis. The addition of sodium ion to the electrolyte when at all effective caused too high a pH to be maintained in the catholyte compartment. Addition of ammonium ion, while at first showing indications of desirable effects, was found to be ineffective for extended electrolyses within the solubility range of $\text{Ni}(\text{NH}_4)_2(\text{SO}_4)0.6\text{H}_2\text{O}$.

The characteristics of nickel sulphate-fluoborate baths with soluble nickel anodes have been studied by the U.S. Bureau of Standards and reported to be the only nickel baths that were buffered effectively. Electrolyte compositions in line with these baths were tried; it was found that these sulphate-fluoborate electrolytes gave deposits of satisfactory physical characteristics and were effective in the limitation of hydrogen evolution over a wide pH range, and that cell conditions

would stay in equilibrium for indefinite periods, thus making possible the deposition of the thick cathode deposits desired in electrefining or electrowinning of metals. The nickel deposits formed from nickel sulphate-fluoborate electrolytes had less tendency to split, peel, pit, and tree than did those deposits formed in other electrolytes. As it is necessary to control the pH of the solution from which the nickel was deposited, a compartment cell was used for all experimental work.

The purified electrolyte was introduced into the top of the cathode compartment, flowed down the face of the cathode, and out of the cathode compartment into the anolyte compartment. The cathode frame was constructed of a single piece of phenol-formaldehyde plastic board; the nickel-winning cell was made of hardwood lined with a thin coating of soft rubber; the outlet boot and anodes were made of soft lead.

Expressing Rate of Flow

As the speed of circulation of the electrolyte was found to be a very important variable in relation to the cathode current density and to the nickel concentration of the catholyte feed, a method expressing rate of flow, taking into account these other variables, was evolved. By definition, the "flow number" is equal to the ratio between the nickel in solution actually introduced into the cell in the catholyte feed in a unit time and the amount of nickel that could theoretically be plated from the solution by the current through the cell in the same unit time. This may be expressed mathematically by the equation:

$$\text{Flow number} = \frac{\text{Grams of nickel introduced per hour}}{\text{Amperage through cell} \times \text{electrochemical equivalent of nickel}}$$

Using nickel sulphate-fluoborate electrolyte of the following composition:

	Grams/litre
Ni	30
NaF	4.2
H_3BO_3	20
pH catholyte feed	5.8

at a temperature of 30°C., a study was made of the effect of variations in current density, with the following results:

Current density	Flow number	Volts across cell	Kw.-hr./lb. nickel
20.6	6	4.40	1.83
18.5	6	4.20	1.74
9.25	6	3.2	1.34

Cathode ampère efficiency for these tests was 100 per cent., as at a flow rate as high as 6 the catholyte pH was maintained at such a point as to prevent the evolution of hydrogen. The deposits formed at higher current densities were finer-grained than those formed at low cathode current densities.

As the flow through the cell was reduced, the pH of the catholyte solution was lowered. The results of this were reduced ampère efficiency due to hydrogen evolution, reduction of voltage across the cell owing to lowered resistance of the catholyte, and higher energy requirements per pound of nickel deposited. However, in spite of the seeming technical disadvantages of operating at a low flow number, there are economic advantages in so doing. At high flow numbers only a small percentage of the nickel introduced into the cell in the catholyte feed is deposited on the cathode, but at low flow numbers virtually all the nickel introduced is plated. When operated at a low flow number of approximately 0.75, the anolyte discharge would contain 5 grams nickel per litre out of the 30 grams per litre in the pure nickel catholyte fed to the cell; the 25 grams per litre extracted electrolytically from

* From the U.S. Bureau of Mines Report of Investigations, No. 3483.

the catholyte and deposited on the cathode would have been replaced with a chemical equivalent of sulphuric acid, making the acid concentration of the cell discharge 4.2 per cent. sulphuric acid. This dilute acid solution then could be returned to the copper leach tanks after having been made up to the 100 grams per litre sulphuric acid required in the leaching operation.

Since the purpose of this part of the work was to develop an insoluble-anode, electro-winning-nickel process, it was necessary that the deposition conditions should be such that the cell would stay in equilibrium for extended periods. This was necessary as industry demands electrolytic nickel cathode of certain minimum thickness. It is also quite expensive to remove and strip the cathodes more often than is absolutely necessary. Consequently, plating conditions were maintained for 120 hours. At the end of such a period, two plates of nickel were stripped from the cathode, one from each side. The plates were more than $\frac{1}{8}$ in. thick, which is acceptable to industry. There was no technical reason why the time of deposition could not have been extended.

Alumina from Phonolite

A New German Process

RENEWED investigation is being given to phonolite (clinkstone) in Germany as a possible domestic raw material for the manufacture of aluminium, according to a comment in "Mineral Trade Notes" of the U.S. Bureau of Mines.

Germany has only meagre reserves of bauxite, mainly in the Vogelsberg in Upper Hesse, where the ore occurs as lumps scattered in loam, necessitating sorting before it can be obtained pure. The limited scope and character of these deposits make their utilisation difficult and costly for the manufacture of aluminium. Various processes have been developed for utilising German clay, and while technical success has been achieved and a limited production is being developed, production costs are high.

In an effort to find some other domestic raw material of sufficient abundance and cheapness producers are turning their attention to phonolite. Extensive deposits occur in various parts of Germany, especially in the volcanic Eifel mountains, the Black Forest, Vogelsberg, and Sudetenland. These deposits vary greatly in chemical composition. The best Eifel phonolite contains from 20 to 23 per cent. alumina, 7 to 9 per cent. K_2O , 6 to 8 per cent. Na_2O , and 50 to 52 per cent. silica.

In the production of aluminium all three principal components of phonolite can be utilised economically, the alumina going into the manufacture of aluminium, the alkali solution being processed to potassium and sodium carbonate, and the main group (by weight), calcium silicate, being used in the manufacture of cement.

In the production of alumina, alkali is added to the finely ground mineral and then mixed with as much finely ground limestone as will enable the formation of the silicic acid calcium-ortho-silicate, and the mixture is then sintered at about 1200° C. The phonolite-silicate complex is thus split so that the alkali in the mineral (together with that added) and the alumina form alkali-aluminate, while the silicic acid is united with the lime. Sintering in rotary furnaces is so carried out that the mass does not become fused but remains porous. Decomposition amounts to 80 per cent. and over. Processing of the sintered mass is carried on by means of soda as in the pyrogenic decomposition of bauxite. Leaching out produces a potassium-sodium aluminate liquor from which pure alumina is obtained in the customary manner. The well washed-out residue, incorporating chiefly calcium silicate and most of the minor components of the phonolite, can be used for manufacturing cement, especially as the residue occurs in the form of silt and does not require any processing.

Bureau of Analysed Samples

Report of Year's Working

DURING the year to November 30, 1939, the Bureau of Analysed Samples, Ltd., Middlesbrough, has issued the following new standards with preliminary editions of the certificates of analyses:—

88/10/2 Gunmetal named Bronze "C" (No. 207).

High Si and High P Cast Iron (No. 206).

The following new standards are in course of being analysed:—

78/80 per cent. Ferro-manganese Steel (No. 208).

18/8 Stainless Steel (No. 209).

Bronze "C" is the first standard to be prepared to correspond with the B.S.I. specification for gunmetals, and indicates the policy which the Bureau decided to follow as far as possible, after discussing with the Director of the British Standards Institution, a year or two ago, in what way his Institution and theirs could collaborate.

Some months ago, when a sub-committee of the British Iron and Steel Federation was investigating the question of rapid reliable methods of analysis, it applied to the Bureau for a supply of several British Chemical Standard Cast Irons to assist it in the investigation of the combustion method for sulphur. Furthermore, its official figure for sulphur by the combustion method was published in the certificate of analyses of Cast Iron No. 206.

War conditions have resulted in a somewhat greater demand for standard samples, though regular business with Poland and Czecho-Slovakia has, of course, ceased. This year constitutes a record for the sale of the Bureau's standards. The sales amount to £2,613 in value, which is about £450 greater than the previous year. In view of increased war costs it is proposed to advance prices of standards and students' samples by 5 per cent., which may be regarded as a very moderate figure and will no doubt be readily accepted in present circumstances.

Interest in spectrochemical analysis for steel is growing and the directors are giving some thought to the advisability of preparing a series of suitable standard pieces.

ELECTRODEPOSITORS' TECHNICAL SOCIETY

The annual general meeting of the Electrodepositors' Technical Society was held in London recently, with Dr. H. J. T. Ellingham, President of the Society, in the chair. The accounts for the session were presented and the Hon. Secretary's report referred to the advantages which had resulted from the recent centralisation of the Society's administration at the Northampton Polytechnic. Dr. S. Wernick, the hon. secretary, mentioned, however, that for the first time for many years there had been some falling off in the number of members, a situation which he hoped would be remedied during the ensuing year. The normal annual number of meetings, ten in London and nine in Birmingham, had been held during the year, and the total number of papers presented at the meetings was twenty.

In his presidential address on "The Metals," Dr. Ellingham discussed the relationship between metals when arranged in order of such diverse categories as: market price; value of world output; standard electrode potential; free energy of formation of oxides; atomic number; and distribution in the earth's crust. He drew attention to certain principles affecting the production of metals and to the range of application of electrolysis in the extraction and deposition of metals.

THE TECHNIQUE OF SINTERING METAL POWDERS in an electric furnace without the application of pressure is stated to have been developed in Germany to a degree making possible the production of nickel blocks from carbonyl nickel powder up to a weight of 1,600 kg. These blocks are now rolled into sheets measuring 5,000 by 2,100 by 12.5 mm which are used in the coating of steel plates used in chemical plant construction.

Current Topics

Carbon Arc Welding Improvements

IN the latest type of carbon arc welding apparatus of the A.E.G. several improvements have been incorporated to make for more economical and speedy working. All parts of the carbon holders are cooled with water and the apparatus can be handled with great ease even when using very high current densities. Very efficient cooling of the cable leading up to the holder is achieved by leading it through a tube through which water continuously flows. The cable is not covered in any way and may be of very small diameter. The current passes from the holder to the head of the welding tool through a water-cooled copper tube which surrounds the head in the form of a magnet and prevents the arc from curving sideways. In view of the considerable radiation of heat the distance between holder and head is rather large and the holder is fitted with a protective screen for the same reason. Perfect results are obtained with carbon arc welding of thin sheets. The welds are rendered pore-free and otherwise improved in the case of thicker sheets with the aid of a special paste which is applied to the welding edges. Another field in which carbon arc welding is gaining ground is in foundry repairs and in cutting operations where a sharp division is not essential, as in the removal of excrescences from castings.

Centrifugal Steel Tubes

THE avoidance of unduly rapid fall in temperature during the production of steel pipes by the centrifugal process is a problem that has long engaged the attention of manufacturers. Several types of heat-insulating coatings on the interior of the mould have been tried but suffer from one defect or another. According to H. Stoz the best results are obtained with the aid of a coating formed from very small steel turnings (0.5 to 1.5 mm. is the order of size recommended). When these turnings are placed in the rotating mould the centrifugal force distributes them evenly over the surface where they form a soft, pasty coherent mass in contact with the molten metal. This layer of turnings is a bad conductor of heat owing to the presence of enclosed air. Turnings of the correct size must be used because if too small they become excessively soft and are then carried away by the molten steel. Tubes made in this way are reported to be free from a hardened skin and the strains are so minute that a subsequent annealing treatment is unnecessary.

Nickel and Copper Recovery in the U.S.A.

PRODUCTION of electrolytic nickel and copper by direct electrolysis of an electric converter metal is discussed in a report just published by the Bureau of Mines, United States Department of the Interior. The report describes the treatment of low-grade nickel copper sulphide ores from Nevada, at the Bureau of Mines Electrometallurgical Laboratory, Boulder City, Nevada. United States production of nickel includes only minor quantities of secondary metal recovered from scrap-nickel anodes, nickel-silver, and copper-nickel alloys (including Monel metal) and small quantities of primary metal recovered in copper refining, the value being about \$1,600,000 annually. Nickel ore, nickel alloys, bars, etc., imported into the United States in recent years have been valued at about \$23,000,000 annually. The type of mineralisation of the

ores tested is compared to that of the Sudbury Basin, Ontario. An organised magnetometer survey followed by diamond drill exploration of the outcrops is believed to be justified. Ore analysis varies from 0.5 per cent. to 1.65 per cent. nickel, from 0.5 to 2.9 per cent. copper and contains appreciable values of metal of the platinum group. Bulk flotation concentrates of the low-grade ore were made, with 92 per cent. recovery of the copper and 95 per cent. recovery of the nickel. Analysis of concentrates gave 4.6 per cent. nickel and 6.1 per cent. copper, and 0.327 oz. platinum group metals per 2000 lb. Waste slags from the electric furnace smelting of these concentrates analysed 0.11 per cent. copper and 0.05 per cent. nickel. By means of an oxygen-air mixture and electrothermal energy the production of a lower sulphur converter anode metal was made possible. The analysis of this metal is: nickel 39.4 per cent., copper 44.4 per cent., iron 0.3 per cent. and sulphur 13.2 per cent.

Coke Ovens in Scottish Works

CONTRACTS have been placed for the erection of coke ovens at the Coatbridge furnaces of Messrs. Bairds and Scottish Steel, Ltd. These, when completed with a gas screening plant, will enable the surplus plant from the furnaces to be utilised for fuel at the company's steelworks and ironworks at Coatbridge. This is the first instalment of a £500,000 reconstruction and extension scheme which is to be carried out. An order has also been placed to extend the cogging mill at the Northburn Steelworks, which will increase the output considerably on light sections, while the furnaces there are also to be enlarged. Another battery of ovens is being erected at the firm's works at Kilsyth for the production of foundry and electrode coke. Bairds and Scottish Steel, Ltd. is an amalgamation of William Baird, Ltd. and the Scottish Iron and Steel Co., Ltd., formed a year ago after the refusal of Glasgow Corporation Gas Department to purchase surplus gas from the Gartsherrie Works. An outlet for the gas will now be provided by the scheme. This method of utilising surplus gas was adopted at the Clyde Ironworks, Tollcross, and the Clydebridge Steelworks, Cambuslang, both owned by Colville's, Ltd., last year.

Extensions to British Aluminium Works

MR. R. W. COOPER, chairman of the British Aluminium Co., Ltd., told stockholders at the ordinary general meeting of the company last week that following the completion of extensions to their various works further substantial additions were now being carried out. Their new alumina factory which was successfully put into commission in the spring of last year was already being enlarged, and work had already commenced on the construction of their Lochaber scheme. Mr. Cooper went on to speak of the progress made by two recent developments of the company's metal. One was the Brytal process of the treatment of aluminium, the efficacy of which, he said, had fully justified the hopes expressed, and the other was their free-cutting alloy which had become exceedingly popular with machinists wherever a light, white metal was required. It is interesting to note that Mr. Cooper added that apart from those specific instances there was a steady advance in the consumption of aluminium for purposes such as architecture, both for construction and decoration, and in the distributive trades.

Paint for Steelwork

Application to Wet and Weathered Surfaces

THE extensive results obtained by J. C. Hudson for the Corrosion Committee of the Iron and Steel Institute, and also several series of tests conducted by the Cambridge Group of corrosion-research workers on the application of paint to steelwork in unfavourable surface conditions are reported by Dr. U. R. Evans in Paper No. 1/1940 of the Corrosion Committee. Results have indicated that admirable protection can be obtained over long periods, even in severely polluted atmospheres, provided that inhibitive paint, followed by two suitable coats chosen for their mechanical properties, has been applied to a surface free from moisture, scale, rust and salt. But if the steel is damp at the time of application good results cannot be obtained and even an invisible film of moisture reduces the protection; in one set of tests at Cambridge, specimens painted in the early morning gave results definitely inferior to those painted in the afternoon with corresponding paints. Far worse is the presence of broken mill-scale on the metal. In the tests carried out by K. G. Lewis at Cambridge, the worst results were obtained when steelwork had been allowed to weather before painting for a sufficient period to produce small holes in the covering of mill-scale; this appeared to be an example of the intense corrosion always set up where a large cathodic area (the part covered with mill-scale) is associated with a small anodic area (the breaks in the mill-scale).

Since in practice steelwork may have to be painted under unfavourable weather conditions and since the removal of scale and rust by pickling or sand-blasting is not always an economical process, it is of vital interest to develop paints which can be applied to surfaces which are (a) wet with water, (b) partly covered with mill-scale, or (c) carrying the residual rust left after wire-brushing. Water-emulsion paints capable of being applied to wet steel are made at present, but these are mostly bituminous paints. It seemed important to develop a typical inhibitive oil paint dispersed in an aqueous medium for application in wet weather. The first attempts at Cambridge led to paints of unstable properties or otherwise unsuitable technical character. J. E. O. Mayne has now examined emulsion paints pigmented with red lead and metallic zinc, which, when applied to steelwork fully wet with water, give good coats.

The question of painting steel partially covered with scale and rust residue is a more complicated problem. Attempts have been made, especially in America, to develop inhibitive washes which, it was hoped, would bring weathered steelwork to a state suitable for painting. There seems some little doubt, however, whether these washes in all cases fulfil the claims made for them, and the opinion in America is veering round to the view that the removal of scale and rust by pickling or sand-blasting is still necessary, even if inhibitive washes are used. It seemed possible that, if soluble inhibitive substances, such as potassium chromate, were introduced into the aqueous dispersion medium of emulsified paint, the necessary inhibition of the corrosion couples present on partly descaled metal might be obtained during the application of these emulsified paints, thus avoiding the additional process (the application of the inhibitive wash). The first attempts at Cambridge to introduce soluble chromates into the emulsified paint led to instability of the emulsion, but this difficulty was subsequently overcome by Mayne by adjustment of the composition. However, it was found that the presence of potassium chromate caused rapid development of fresh rust at the points where the microscopic rust particles left after wire-brushing existed. This rapidly caused the pushing away of the paint-film in microscopic pimples during the drying. The rapid rust production at points where rust residues exist on a weathered steel surface could be brought about by potassium chromate solutions in the absence of paint, and a study of the matter suggested that it was due to residues of iron salts, probably ferrous sulphate, in the rust particles. This combination gave rise to the cell. Iron/ferrous-sulphate/

potassium-chromate/iron. Since here again there was a small anode and large cathode, the attack was locally very intense. Accordingly it was decided to abandon the use of soluble chromates and indeed of such slightly soluble pigments as zinc chromate. It seemed possible that the same beneficial effects as had been sought through the use of soluble inhibitors might be obtained by using an emulsion paint containing metallic zinc pigment, which would send local currents in the opposite direction and might perhaps overcome the effect of the cell iron/mill-scale, without the use of inhibitive washes or soluble inhibitors in the paints.

Accordingly Mayne exposed on June 19, 1939, some preliminary specimens coated with emulsified metallic zinc paints and emulsified red lead paints. Certain portions of each specimen were coated with ordinary iron-oxide oil paint over the emulsified primer, whilst another portion of each carried iron-oxide paint alone. These specimens were exposed to the Cambridge atmosphere, but the rising of the paint has not been prevented in cases where mill-scale was present; scale-free specimens, even though painted when wet with water, were behaving well after three months' exposure. Although some years must elapse before a decision can be given, it would seem probable that the problem of painting wet metal has been solved, but that the problem of painting partly weathered metal has not been solved. The specimens exposed carried emulsion paints of a relatively preliminary composition.

Letters to the Editor

Organised Supply of Metals

SIR,—Users and designers of industrial and domestic plant and equipment are finding themselves handicapped by shortage of or delay in obtaining certain ferrous and non-ferrous metals. It may assist them to learn that the Ironfounding Industry has organised itself to help in the present emergency. During the past twenty years an enormous amount of work has been done to increase our knowledge of the range of materials known as the Cast Irons, and many of the varieties available have properties not generally associated with cast iron. Almost any metallurgical structure required can be obtained in a wide range of strengths and standard national B.S.I. specifications are available for users, particularly 321/1938 and 786/1938. The industry itself has made great strides in continuous production methods, and generally in the precision of form, uniformity and soundness of the product, and where necessary a wide variety of finishing processes is available. Almost the whole of the raw materials employed are found within the United Kingdom and manufacture is widely distributed.

The industry has formed the Ironfounders' National Committee, and information will be gladly sent by me or can be obtained from the Chairman of our Technical Committee, Mr. J. G. Pearce, British Cast Iron Research Association, 21 St. Paul's Square, Birmingham, 3. No recommendation will be given unless there is a reasonable likelihood of the substitute material giving satisfactory service, and no charge or obligation will be incurred.

For specific cases, it would be an advantage if inquirers could send a print of the part in question, say what it has hitherto been made of and, if working under unusual service conditions (stress, temperature, wear, corrosion, etc.), what life is normally obtained. It is also desirable to know whether design in the alternative material must be a copy of the existing part, or whether conditions permit a measure of redesign.—Yours faithfully,

W. R. BLAIR,

Director,

Ironfounders' National Committee.

London, W.1. March 19.

Metallurgical Section

May 4, 1940

A SURVEY OF THE HIGH SILICON IRONS

by BRIAN N. REAVELL, B.Sc., A.C.G.I.

THE high silicon irons are well-known in the chemical industry and may be regarded as covering a group of iron alloys containing from 12 to 20 per cent. of silicon as the main constituent. These alloys are characterised by their high resistance to chemical attack and their hardness. For use in the chemical industry, the silicon content is generally between 13.5 per cent. and 17 per cent. A reduction of the silicon below 13.5 per cent. results in a rapid falling off of the chemical resistance, and an increase in the silicon content beyond 17 per cent. increases the brittleness, and for most purposes renders the alloy impracticable for use in chemical plant.

TABLE SHOWING A COMPARISON BETWEEN THE PHYSICAL PROPERTIES OF A TYPICAL SILICON IRON CONTAINING 14-15% SILICON WITH ORDINARY CAST IRON.

	Cast Iron.	Tantiron.
Density	7.3	6.8
Tensile strength, tons per sq. in. ..	9-10	6-7
Transverse strength of 12 in. x 1 in. bar ..	2500 lbs.	1600 lbs.
Crushing: 1-in Cubes	40 tons	34 tons
Melting point	1250° C.	1400° C.
Hardness	1	1.6
Heat conductivity	10	8
Electrical resistance	8	10
Contraction allowance in casting ..	$\frac{1}{8}$ " per ft.	$\frac{3}{16}$ " per ft.

The first production of silicon iron castings cannot be attributed with any certainty to one man, but it is generally accepted that Jouve was the first to employ silicon iron for the construction of chemical plant before the year 1900. The name of "Métillures" was given by Jouve to the silicon iron materials that he made, and a patent is on record in his name, taken out in 1903.

The use of silicon iron was studied in other countries inspired by the results of Jouve's investigation. In England, first Lennox, then Pearce and Marsden, brought out a proprietary brand of silicon iron; in Italy, Dr. Rossi manufactured his own silicon iron equipment for use in synthetic nitric acid plant; in America, the Duriron Company began to operate; and in Germany Krupp took up the manufacture of the material. Not unnaturally, the alloys made by the different firms varied somewhat in composition and method of manufacture, although the analysis of typical samples, published in *Chimie et Industrie* (November, 1919) showed remarkable similarities.

	Métillure	Elia- nite	Ironac	Dur- iron	Tant- iron
Silicon	16.92	15.07	13.16	15.51	14.56
Iron	81.05	82.40	83.99	82.23	82.94
Manganese	0.88	0.60	0.77	0.66	0.74
Aluminium	0.25	—	—	—	—
Carbon	0.592	—	1.08	0.83	1.20
Phosphorus	0.173	—	0.78	0.57	0.08
Sulphur	0.01	—	0.05	0.01	0.05

The best known firms producing silicon iron on a commercial scale in the pre-1914 period, and the trade names under which they were sold are given in the following table:—

TANTIRON—Lennox Foundry Company, England.

IRONAC—Houghton's Patent Metallic Packing Co., Ltd., England.

METILLURE.—Société des Métillures, France.

ELIANITE—Dr. Rossi, Italy.

NEUTRALEISEN—Fredk. Krupp, Germany.

DURIRON—The Duriron Company, U.S.A.

There is not a great deal of published research on the manufacture of high silicon iron and it is unfortunate that in most cases the investigations have been carried out without collaboration between the various workers. We see in reviewing the results a great deal of unnecessary waste of energy through duplicate work. The metallurgical examination of this alloy presents an extremely difficult problem, and, particularly in the early days, a suitable technique was not sufficiently developed to produce conclusive results. The researches were in most cases a matter of trial and error, rather than scientific investigations, but the fact remains that one or two firms in the important producing countries were able to manufacture chemical plant in high silicon iron which fulfilled a highly valuable purpose. The manufacture of gunpowder and explosives and the production of nitric acid led to a big demand for chemical plant made in silicon iron. Cooler coils, concentrating basins, acid circulating pumps, retorts, de-nitrating columns, pipe condensers, valves, etc., were all made in silicon iron for such purposes.

When war broke out in 1914, high silicon alloys became essential to the factories manufacturing explosives, and it is probable that the relatively large demand that ensued hindered a proper development in the improvement of the material. Those firms who knew how to make silicon iron with some degree of success were too busy turning out work to spend time or money on research. This state of affairs was not helped when peace came. The demand for high silicon iron was reduced, and the future for the alloy seemed poor. This state of affairs did not exist to such an extent in America, and the Duriron product was developed progressively.

A further set-back to the development of high silicon iron was the rapid advance in the production of austenitic stainless steel, which in many cases replaced high silicon iron. The resistance of stainless steel to nitric acid at varying strengths and temperatures, the high strength of the material, the relative ease with which it could be worked, and the great publicity which it was given, tended to reduce still further the effort of the silicon iron manufacturers.

German Secrecy

Shortly after the war Krupps in Germany had produced a superior grade containing 16 per cent. of silicon for which extravagant claims were made, and a paper by Richard Walter, of Düsseldorf, read in 1921 to the Deutsche Gesellschaft für Metallkunde, advertises the virtue of this new silicon iron called "Thermisilid," but avoids description of the new process in the following terms: "I should like to make an additional statement here. You have seen that the process is being used industrially and we have every interest, in view of the unsettled economic and political situation, in protecting German industry against foreign countries. This is particularly necessary because the patent situation with reference to Entente countries is to-day very uncertain. Consequently with these conditions in mind I have not been able to express myself more openly concerning individual points of the process which would have needed a detailed discussion from the scientific viewpoint. A series of patents has already been taken out but there are a lot of applications

for patents on such a process in foreign countries, and the utmost caution is advisable to-day with patent protection against foreign countries in order to prevent unfair exploitation and incidentally injury to our own industry." It is natural that the development of high silicon iron in Germany should have been pushed forward with the coming of the Nazi regime for purely economic reasons.

If we consider the alternative materials for constructing acid-resisting chemical plant for use with nitric and sulphuric acid, such as lead, stainless steel and rubber lining, all of which require material difficult to import, we see that Germany could better afford to obtain her ferro-silicon pig from Norway, and use high silicon iron instead of the other materials.

Now that we are at war, the position in England is suddenly changed, and high silicon iron is required in vastly greater quantities than ever before. It can replace stainless steel for many purposes, and so allow the nickel, molybdenum, and chromium to be used in other alloys for which no substitutes exist, e.g., for high-speed cutting tools. It is, therefore, essential for the country that silicon iron should be manufactured on a greatly increased scale. It would, however, be a mistake to give effect to this increased output on the manufacturing lines of the last war, without having regard to the improvements that have since been made. Much knowledge has been accumulated since 1918 and the most up-to-date methods of manufacture only should be employed for the increased production.

Studies of Melting Methods

It is interesting to note that the trend of development in 1919 was directed more to the possible inclusion of certain elements that were felt to be desirable in improving the product, rather than the investigation of the means of melting the metal. In a paper on the subject by Monsieur C. Matignon, the author dismisses the question of melting practice in the following manner: "Certain manufacturers carry out the fusion in a cupola, others in an electric furnace—local conditions seem to determine the choice. It is evident, however, that the possibilities of the process are greater with the first than with the second." It has since been shown that melting in a cupola cannot give such good quality metal as that obtained in an electric furnace, or in a crucible, and it is now considered of primary importance that a cupola should not be used for producing castings if good quality and reliability is required.

High silicon iron castings are known to be brittle, and plant failures may be caused by the inherent weakness of the metal. The average tensile strength for silicon iron casting containing 14.5 per cent. silicon would be 6 to 7 tons per sq. in., compared with the average of 9 to 10 tons per sq. in. for grey iron casting. There are, however, other factors that account for breakage of castings which should not be confused with the weakness of the metal. It was commonly found in the past that high silicon iron castings, when fractured, exhibit large gas pockets with inclusions of free graphite. These pockets weaken the section of the castings and frequently cause them to fail. Modern melting methods and foundry technique have eliminated the graphite inclusions, thereby greatly increasing the strength and reliability of the castings without necessarily making a change in the analysis of the alloy. It is frequently stated that high silicon iron castings should be annealed for satisfactory results, but there is no clear evidence to indicate the advisability of this procedure. In almost every case, by careful design of the casting, and the correct melting and foundry technique, a sound casting can be produced which would not be improved by annealing. It is, however, possible, with a badly designed casting and with poor quality metal, to produce a mechanically sound casting if it is annealed, whereas the casting would crack immediately on cooling without the annealing. The correct procedure, therefore, should be to improve the design of the casting, the melting practice and

the foundry technique, rather than to attempt to hide the defects in the metal by annealing.

Every worker who has studied the production of high silicon iron castings with a view to improving the quality of the metal has investigated the possibility of adding small quantities of other elements such as boron, nickel, copper, aluminium, etc., and claims, sometimes greatly exaggerated, have been made for special silicon iron alloys of this sort. However, the fact remains that the best known silicon irons, even to-day, are not alloyed in this way, which may indicate that these additions are valuable more as a selling point, than from the metallurgical point of view.

A Difficult Welding Problem

The welding of silicon iron castings is an extremely difficult problem, but it is a matter that deserves a great deal more study than has hitherto been given to it. The brittleness of the metal and its susceptibility to fracture through thermal shock make it particularly awkward to carry out a successful weld on large and complicated castings. Also the necessity of maintaining the correct silicon content of the weld metal raises further problems. If a satisfactory technique could be evolved it would simplify the construction of complicated castings, and the designer could combine a cast and welded construction to produce the desired shape. Although welding rods are available, their use is very limited. The most promising results have been obtained by the oxy-acetylene process, but the whole subject of welding high silicon iron is still in its infancy.

Workers who have carried out the most thorough investigations in the manufacture of high silicon iron are unanimous in insisting that the metal must be free from impurities, low in phosphorus, carbon, and sulphur, and cast with the correct foundry technique; and the position to-day is that all foundries who seek to produce a better quality high silicon iron are concentrating on improvements in the means of melting and foundry technique. However, it is important to remember that even the cleanest metal, poured into perfect moulds at the most suitable temperature, will be a failure unless the designer of the part is fully experienced in the idiosyncracies of high silicon iron and has made his design correctly.

ELECTRODEPOSITION OF RHODIUM

The utility of rhodium sulphamate in the electrodeposition of rhodium was pointed out last year by Piontelli and Giulotto (*Chimica e Industria*, 1939, 21, 478). Further confirmation of the high quality of the coatings deposited from sulphamate baths was obtained in later studies now published in *Chimica e Industria* of February, 1940 (p. 61-2). Glass cells with platinum anodes and copper cathodes were used in these experiments and perfect deposits resulted from operation at the ordinary temperature at current densities ranging from 20 to 1000 amps. per sq. metre. Wide variations were also permissible in the concentration of both the rhodium sulphamate (3-12 gms. rhodium per litre) and the free sulphamic acid (12-35 gms. per litre) without detracting from the quality and finish of the plating. The high resistance of the rhodium coatings was demonstrated in tests involving exposure to gaseous hydrogen sulphide in a closed vessel for one hour.

CYANIDE PLANT FOR GOLD-BEARING PYRITES

An account of the operation of the plant for extraction of gold from auriferous pyrites and quartz from the Montagne Noire, in S.W. France, is given in *L'Industrie Chimique* of March, 1940. This plant is located at Combe du Saint (Aude). Flotation concentrates containing 35 grams gold per ton are passed through a lengthy cyaniding process before treatment by the Meril process in which zinc powder is added to the deaerated solution and the black precipitate of gold is filtered in a press before final treatment.

Current Topics

Alloy Steels of High Elastic Strength

METALS used in the production of low-carbon highly elastic steels for welding work are manganese, copper, nickel, molybdenum and chromium, and are discussed by Herbiot (*Rev. Universelle des Mines*, Feb., 1940, pp. 41-6). Examples of manganese-copper steels are St. 52 (German), Ac. 54 (French), and Manten-Ductiloy (U.S.A.), the proportions ranging from 0.13-0.25 per cent. carbon, 0.9-1.5 per cent. manganese and 0.3-0.6 per cent. copper. Some grades (e.g., Cromansil) also contain 0.6-0.9 per cent. silicon. The German State Railways have specified the following maxima for high-manganese steels to avoid the possibility of martensite formation: carbon 0.2 per cent., silicon 0.5 per cent., manganese 1.5-1.2 per cent. Typical nickel alloys are Republic Steel RDSI and RDSIA and Inland Company Hi-Steel, all of which are weldable and may contain 0.08-0.25 per cent. nickel and possibly a little copper. Swindon and Reeve have pointed out that nickel and copper notably improve the strength of tempered steels. Molybdenum steels are notable for fineness of structure and stability after hammer-hardening and exposure to high temperatures which renders them particularly suitable in the construction of welded boilers. The usual limits for high elasticity are 0.13-0.3 per cent. carbon and 0.2-0.6 per cent. molybdenum. Chrome-phosphorus steels extensively used in the United States are typified by Corten, which has a maximum of 0.1 per cent. carbon and 0.1-0.2 per cent. phosphorus with 0.5-1.5 per cent. chromium. These steels have not been at all widely adopted in Europe and doubt has been thrown by Jones (Iron and Steel Institute Meeting, 1937) upon the advantages of phosphorus. However that may be, there is no doubt about their ease of welding in the laminated form thanks to the very low carbon content.

Solubility of Zinc in Acids

AN important influence is exerted in the electrometallurgy of zinc by metallic impurities which may be present either in the metal itself or in solution. Details of the effect of such impurities on the rate of dissolution of highly purified zinc in 2*N* sulphuric acid are published by R. Piontelli in *La Chimica e L'Industria* of March, 1940 (pp. 109-118). The zinc used originally contained 0.0004 per cent. lead, 0.0005 per cent. cadmium, 0.0008 per cent. iron and 0.0004 per cent. copper. When this was alloyed with pure lead (0.026 to 2.6 per cent.) an initial acceleration of the rate of solution in the acid was noted, but subsequently a marked slowing-down occurred as the surface concentration of lead declined. A much more energetic solution-activator was copper when alloyed in the proportion of 0.19 per cent. Silver (0.1 per cent.) was likewise more energetic than lead, but not to the same extent as copper. Metal salts in solution form increased the speed of solution of zinc in the following order: cadmium (retarding), manganese (inactive), iron, lead, arsenic, bismuth, cobalt, copper, silver, nickel, antimony.

New Uses for Tin

THE fifth issue of *Tin and its Uses*, the quarterly review of the International Tin Research and Development Council, has an article describing in detail the methods which ensure complete adhesion of white metal linings to bearing shells of various materials, and giving temperatures, strength of acid, etc., for the more difficult cases. This article is illustrated by a photograph of a bearing which has been flattened out and bent in the reverse direction, the lining still adhering perfectly, in contrast with another bearing, not properly prepared, from which the lining has separated. A new process developed in the Council's laboratories is the production of a protective oxide film on tinplate. Although it is so thin that

it is invisible, it has been found to give good protection from sulphur staining when tested with foods, and it may prove an alternative to expensive sulphur-resisting lacquers. Further research is being carried out in collaboration with the appropriate industrial organisations. Progress in research on high-tin bronzes for condenser tubes is recorded. Comparative tests in circumstances closely approximating to actual service conditions clearly demonstrate the uniformly high corrosion resistance of the tin-rich bronzes. Another article contains information that should be of assistance to manufacturers in choosing brands of tin suited to their particular purpose. The approximate amounts of impurities which may be expected in each brand are tabulated, and it is explained that it is not necessarily advantageous in every case to use highly pure tin.

Metal Sheets for Current-Rectifying

PRODUCTION of oxidised metal sheets which are claimed to function as good current-rectifying agents is described by J. Berényi in Hung. Pat. 120,403. Sheets of any metal are copper-plated in the usual way and then placed in an electric furnace at 1020°-1080° C. for 10-20 minutes. This is followed by exposure to pure oxygen to form a superficial coating of copper oxide and finally by repeated cooling at 0°-15° C. This treatment results in formation of triangular crystals of copper oxide which possess an excellent rectifying action.

British Steel Supplies

Explanation of New Distribution Scheme

THE problems affecting Great Britain's supply of steel were discussed at a recent meeting of the Mining Institute of Scotland in Glasgow. Mr. C. C. Reid, president of the Institute, introduced Professor A. M. Bryan, of the Royal Technical College and Glasgow University, who opened a discussion on "Supplies and Economy in War-time."

Professor Bryan, who has been acting as Deputy Director of Mining Supplies at the Mines Department since the outbreak of war, explained features of interest in the new Ministry of Supply scheme for the distribution of steel, which came into force on April 1. He pointed out that the primary object of the scheme was to ensure an equitable distribution among consumers of such steel supplies as were available from time to time, bearing in mind the relative urgency of competing requirements. It was hoped that this would ensure that the needs of all departments of the war services would be met without delay in delivery, and yet would afford supplies for public services and general industrial use on a more adequate basis than had hitherto been the case. The estimated steel requirements of the war services and Government departments and other consumers had been carefully examined and pruned so that these now came within the estimated productive capacity of the steel industry. On that basis allocations of steel had been made to each service or department responsible for the supplies of steel to the various classes of consumers.

EXPANSION OF FAR EAST IRON OUTPUT

An event of considerable significance in the Far Eastern economic field is the impending exploitation of virgin iron and coal deposits in remote parts of Japanese-controlled territory in Manchukuo. Near the Korean frontier is the Tungpientao minefield with estimated reserves of 100 million metric tons of rich iron ore which is marked down for exploitation by the Tungpientao Development Company. Outputs of iron ore and coal are each expected to be at the rate of 1,300,000 tons per annum by the end of 1941. Steel and cast iron foundries are under construction and a railroad will link up the new industrial zone with Korea.

Manganese-Aluminium Alloys

Advantage of Electrolytic Mn

DIX, FINK, AND WILLEY, as reported in the U.S. Bureau of Mines Report of Investigations 3477, have studied some alloys of quite high purity containing up to 10 per cent. manganese. They report that alloys up to 2.49 per cent. Mn were rolled to 22 gauge, but only after heating initially for 17 hours at 600° C. and again annealing for 22 hours at 600° at 2 gauge. They do not say whether this represents the upper limit of rollability even with these precautions, but it may be so inferred. Bradley and Jones also fail to report data on workability, but do report that all the alloys made were ground to a powder for X-ray study. The lowest manganese alloy made was 7 per cent. Mn, so that we may assume this to be brittle. Dix, Fink, and Willey show a macrograph of a 10 per cent. alloy exhibiting a needle-like surface, which would certainly denote brittleness. This ingot was made from rather impure manganese having the composition 1.63 per cent. Si, 1.24 per cent. Fe, 0.12 per cent. Cu, 0.85 per cent. Al, and 96.16 per cent. Mn by difference. The authors say that the results obtained indicate that the impurities introduced with the manganese had no substantial effect on this portion of the diagram. The maximum manganese in any of these high-purity alloys made from aluminium and manganous chloride was 6.23 per cent.

Rate of Cooling

This last alloy was studied during very slow cooling of some 2½ kg., and it was found that at 710° the melt had almost completely solidified, but on slow cooling became liquid again, presumably by decomposition of the first crystals to separate into another phase and liquid. It appears that the first crystals are MnAl, which decompose at 710° into MnAl₆ and melt. Krings and Ostmann found only MnAl₆ at the aluminium end of the system and placed the eutectic between this compound and Al at 3 per cent. Mn. Evidently, the compound MnAl₆ does not always form, the result depending no doubt on the rate of cooling and presence of impurities.

The authors have compared the behaviour of both electrolytic and presumably silicothermic manganese when heated with relatively high purity Hoopes-process aluminium at 900° C. in clay crucibles. Both kinds of manganese were sized through 10-mesh on 28. Ten per cent. of manganese and 90 per cent. of aluminium were used in each case.

The initial rate of solution for the electrolytic manganese was a little higher. After 10 minutes, with no stirring except on sampling, the electrolytic manganese had formed an alloy containing 2.25 per cent. manganese while the silicothermic manganese had only dissolved to the extent of 1.5 per cent. manganese. At the end of 20 minutes, however, the two alloys were virtually of the same composition. After 1 hour heating, both alloys contained 3 per cent. manganese. They were cast in a chill mould. The surface appearance and fracture were quite different.

The alloy made from electrolytic manganese was very ductile and was readily rolled down to foil without intermediate annealing. The full cold-rolled alloy had a hardness of R_b 23. The alloy made from silicothermic manganese cracked badly at 50 per cent. reduction and showed a hardness with this small amount of cold work of R_b 20. At 50 per cent. reduction the hardness of the electrolytic manganese alloy was R_b 4. To check this remarkable difference in properties, two more alloys were made in the same way except that the melt was stirred.

The second series of alloys showed 6 per cent. manganese. The alloy from silicothermic manganese was brittle and worthless. The alloy from electrolytic manganese was ductile and could be rolled down to thin sheets with light reductions. A third series of alloys contained 8 per cent. manganese. In these samples the alloy from silicothermic manganese was also worthless for any purpose, but the 8 per

(Continued at foot of next column)

Letters to the Editor

"The Scarcity of Copper and Zinc in Germany"

SIR,—I crave your indulgence to comment on the article written by Dr. Howat in respect of the copper reserves of Germany.

It has to be remembered that statistics taken from *The Mineral Industry* are only of value when properly discussed in their true perspective, and details dealing with ordinary imports and exports merely reveal what is common knowledge to the average mining engineer. A much more important aspect of the situation can be revealed by studying what copper deposits exist in the vicinity of the German borders. Statistics culled from existing literature are only of more or less academic value, and do not give a true light on the present situation.

Although Germany is blockaded from its usual imports of copper, allowance should be made for copper which could be obtained overland. Whether or not this is being done remains to be seen, but the importance of such a possibility cannot be underestimated. Not a little has been published in the popular Press regarding the nickel deposits of Finland, but little if any information is given in respect of the copper deposits. As a striking illustration, the Outokumpu copper mine in Finland is seldom if ever quoted as the largest known copper deposit of Europe, excluding the Russian occurrences.

Statistics, however, and an account of the mining and concentration processes, were given by E. Makinen in *Mining and Metallurgy* as far back as February, 1938, whilst further details were published in *The Mining Magazine*, March, 1938. The proved ore reserves, it is stated, "can now be estimated at about 20,000,000 metric tons, with a total estimated copper content of 800,000 tons." Furthermore, reference was made to the I.C.I. process of sulphur dioxide concentration in connection with the Outokumpu mine in *The Mining Magazine*, September, 1936.

Hence the statistics given by Dr. Howat, which make no reference to such large copper deposits, have to some extent lost their value. Russian deposits of copper remain to some extent a matter of speculation, but no doubts exist regarding the Finnish deposits, which, together with the costs of production, were given in full detail several years ago.

If, as is probable, Germany is able to tap the deposits of Finland, to say nothing of the unknown Russian deposits, the statistics as culled from *The Mineral Industry* of earlier years cannot be regarded seriously.

It may be that the recent war in Finland will have seriously restricted mineral outputs, as has already been the case with the nickel mines, but if systematic figures are to be obtained, the products from countries surrounding or adjacent to Germany must be taken into account. In conclusion, this is not the first time that statistics of the purely academic nature have been published without consideration being given to the general situation of the countries involved, and it is contended that during war-time conditions, all statistics should at least indicate all alternative sources of supply.—Yours faithfully,

A.G.A.

April 26, Glasgow, C.2.

(Continued from previous column)

cent. alloy with electrolytic manganese was still ductile enough for reduction by very light passes and made a dense, tough casting with a hardness of R_b 8.

The alloys were etched with 1 per cent. NaOH for 10 seconds. According to Dix, Fink, and Willey, this darkens MnAl₆, but gives a blue colour with MnAl. Evidently MnAl is the principal manganese constituent in both alloys, but the amount, shape and size of the crystals are quite different. A phenomenon similar to the modification of the aluminium-silicon alloys seems to have occurred.

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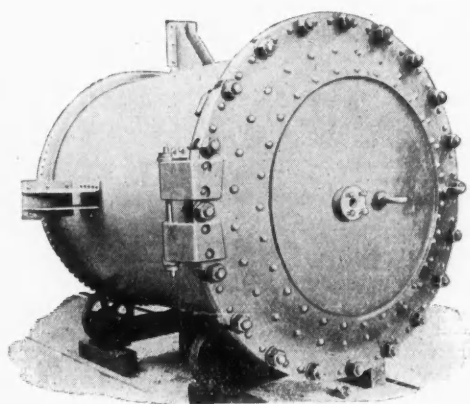
Metallurgical Section

Published the first Saturday in the month.

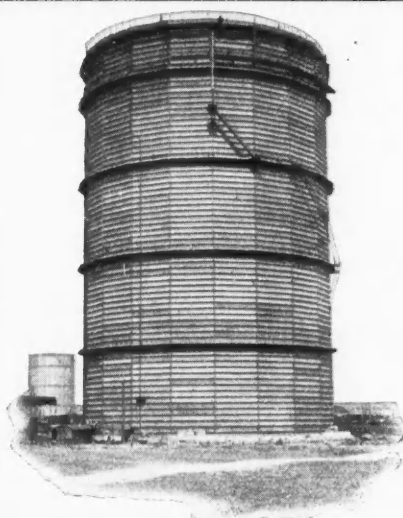
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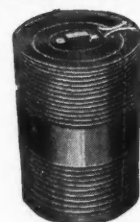
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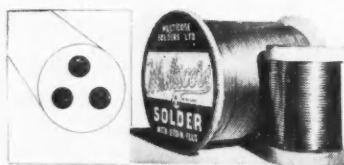
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British-Made Cored Solder

Attractive Booklet Published

PRIOR to the outbreak of war, it seems that many British and Colonial electrical and radio manufacturers, who used cored solder with special fluxes, used to obtain much of their supplies from Germany. Although single-cored solder, with rosin flux, was made in England, there was, with few exceptions, little cored solder available of British manufacture containing special fluxes. Since the outbreak of war, Multicore Solders, Ltd., have developed their cored solder, which contains three independent cores of Ersin flux.

Ersin Multicore Solder is now being used by many of the



MULTICORE SOLDER WITH ERSIN FLUX

A coil of "Multicore" solder with enlarged section showing the triple core.

leading British radio and electrical manufacturers and, with a view to developing the export markets, which were previously served by German cored-solder manufacturers, the company has produced an attractive and useful twenty-page booklet entitled "Solders and Soldering." This contains 18 photographs and diagrams, in addition to tables of useful data, some of which have been reproduced by permission of the International Tin Research and Development Council and the British Standards Institution. The photographs include reproductions of actual laboratory tests, which show the advantages of Multicore Solder with the non-corrosive Ersin Flux over single-cored solder with pure rosin flux.

Among the tables is one giving the approximate number of

feet per lb. of Multicore Solder in its various alloys. A study of this table by the progressive manufacturer should enable considerable savings to be made in soldering processes, by the avoidance of waste. It is seen, for example, that with a 60 per cent. tin alloy, more than three times the length of solder can be obtained by using 18 S.W.G. Multicore Solder instead of 13 S.W.G.

COPPER SHORTAGE OVERCOME IN INDIA

Millions of Indian housewives ran the risk shortly after the outbreak of war of being forced to revert to the use of baked clay household utensils, because first there was such a world shortage of aluminium that there was none left for shipment to India after war requirements had been satisfied, and secondly because India is only a small producer of copper so that none was expected to be left for the use of the civil population after the requirements of the Defence Services, the Railways and the Mint had been met. The Department of Supply Government of India, began scouring the world for copper and in response Rhodesia came to India's assistance by supplying blister copper to the amount required to keep the Indian market supplied.

(Continued from p. 25.)

tained, there is the possibility that the galvanising on the thinner section will be considerably vaporised and burned before the heavier section has been raised to tinning or fusion temperature. Thus when cast iron and sheet are being joined, it is advisable to preheat the casting so that both parts can be brought to welding temperature simultaneously.

The use of adequate jigs is also important. Jigs designed for welding galvanised metal should, if possible, possess some means for quickly conducting the heat away from the welding zone. They should also be so arranged as to provide the operator with maximum space and freedom of movement for manipulation of the blowpipe.

Metallurgical Section

June 1, 1940

WELDING GALVANISED IRON

Application of Zinc

by H. SEYMOUR

WHEREVER uncoated iron or steel would be subject to corrosion galvanised iron is commonly used. The galvanised coating, however, offers no difficulties in joining these materials by welding. In fact, the practice of welding these materials results in joints which are decidedly superior to those which can be obtained by other methods. In pipe, for example, the welded joint effects no reduction in wall thickness as is the case with threaded joints. Although some of the galvanised coating is removed by the welding flame, this in no way exceeds the amount removed by the threading process. Further, welding can actually increase the corrosion resistance of the metal, in the small zone where the galvanising is removed, since the heat of the welding flame appears to cause the formation of a highly resistant metal oxide.

In sheet, the advantages of the welded joint are even more apparent. For example, one of the most common joints employed by sheet metal fabricators—the lock-seam and solder-type joint—is usually limited to metal of 20-gauge thickness because of the great difficulty in making a lock seam in heavier gauge metal. Welding puts no limitations on metal thickness and provides a joint which is stronger than the base metal and will not open as a result of rough handling or use.

A few simple precautions should be observed in welding galvanised materials because of the nature of galvanised coatings. The protective coating of zinc, which forms the galvanising, usually measures from 0.001 to 0.005 in. in thickness. It is applied to the iron base material by immersing the sheet, pipe or other form in molten zinc. A layer of flux on the surface of the zinc cleans the iron as it enters the bath and ensures a firmly adherent coating of zinc on the galvanised material. This process is called hot-dip galvanising.

Good Ventilation Essential

Zinc has a relatively low melting point, only 419° C., and also has the property of volatilising or vaporising when heated. Consequently, when galvanised material is heated, as in welding, the zinc coating does not melt and run on the surface as might be expected. Instead, the zinc vaporises and burns, forming white fumes of zinc oxide. For this reason, welding on galvanised metal should be done in well-ventilated locations, as inhalation of zinc oxide fumes released from the galvanised coating may cause temporary discomfort to the worker. Out-of-doors the operator usually can work so that the fumes float away from him. In fairly open indoor locations, it is often sufficient to remove the fumes by suction or to drive them away from the worker by the use of a stream of air. However, in more confined spaces, a mask that supplies air from an outside source should be worn by the operator. A satisfactory type is a simple mask with a large hose leading only as far as necessary to assure a pure air supply. This type does not require an air pump.

All dirt, grease, and oil along the joint should be thoroughly cleaned off before attempting to weld, but the galvanised coating should not be removed. Galvanised pipe or other material can be bevelled by means of the cutting blow-pipe, experience having shown that this does not seriously affect the coating. During welding, it is best to hold heavy objects or complicated shapes in jigs and fixtures

to assure correct alignment. To prevent buckling and warpage, the welding of galvanised sheet is usually done in jigs of the same general type and design as for other sheet metal products. Galvanised materials can be either fusion-welded with the steel welding rod or bronze-welded. However, since bronze-welding is done at a lower temperature, it has less effect on the galvanised coating than fusion-welding, and consequently is the method generally preferred. The welding technique for both fusion-welding and bronze-welding galvanised material is exactly the same as for the corresponding uncoated material.

Welding should be done with the minimum amount of heat consistent with good fusion, in the case of fusion-welding, and with correct "tinning action" where bronze-welding is the process used. In the fusion-welding of galvanised steel piping systems, it is also well to remember that in the latest method of joining pipe, a considerably narrower band of the zinc coating is affected than that which is affected by full fusion-welding. This desirable result is made possible by the greater speed and reduced heat requirements of modern welding.

Fusion welds in galvanised iron are usually given a coat of aluminium paint or similar material. Although it is obviously impossible to paint the inside of many welded joints, experience has shown that such joints give perfectly satisfactory service even without painting. Bronze-welded joints give excellent service without any finishing. For some products, the finished bronze-weld may be coated with aluminium paint to give a uniform appearance.

Importance of Flame Control

From the operator's standpoint, proper flame control is of the first importance because upon it depend other factors leading to a high-quality finished job. Proper control of the welding flame will result in just enough heat input to ensure a sound joint. Excessive heat means the removal of unnecessarily large amounts of the galvanised coating with a corresponding reduction of the protection which it affords. The operator should strive to make a sound weld as he goes along without coming back to reheat and rework portions of the finished weld, and should make every effort to proceed as continuously as possible. In bronze-welding, for example, the number of interruptions caused by dipping the rod into the flux can be reduced to the minimum by fluxing a sufficient quantity of bronze rod before beginning to weld. This can be accomplished either by dipping the cold rod into a molten mixture of flux and water or by rolling the heated rod in dry flux. In either case the flux will adhere to the rod in the form of a coating and the only interruptions during welding will be to pick up a new rod. Thus the possibility of overheating the base metal is materially reduced.

Proper design for welding is also important. The application of bronze on highly-stressed areas should be avoided, since the presence of these stressed areas may result in intergranular penetration or cracking of the base metal in that vicinity. Proper choice of joints will permit the welding operation to be made quickly and smoothly. When unequal thicknesses are joined, unless equal heat application is ob-

(Continued at foot of p. 24.)

Current Topics

Alumina Films

A SATISFACTORY method of producing uniform translucent films of alumina from aluminium foil is described by Vollrath (*J. Phys. Chem.*, 1940, 44, 4, 401-404). Thin aluminium foils can be oxidised completely to alumina by anodic oxidation in a 3 per cent. oxalic acid solution, using A.C. or D.C., and a current of about 30 milliamps., but the films obtained exhibit a sheen which was found to be due to the presence of considerable amounts of unoxidised aluminium, a phenomenon probably caused by electrical isolation of patches of the foil during the course of the oxidation by the formation all round them of non-conducting alumina. This difficulty was overcome by immersing only the end of the foil to be oxidised in the acid, and electrolysis till this part was completely oxidised, then running more of the oxalic acid solution into the cell at such a rate that the part of the foil immersed was always completely oxidised. It was found possible to oxidise foil 0.002 cm. thick at the rate of 2 cm. per hr. Foils as thin as 0.0005 cm. can be oxidised, but the resulting alumina could not be lifted out without tearing.

Germany and Finnish Ores

A RECENT article in the *Deutsche Allgemeine Zeitung* reveals that Germany is very anxious to obtain access to Finland's raw materials. Various complications, however, have arisen as an outcome of the Russo-Finnish War. The nickel ore near Petsamo, for example, has remained in Finnish hands, but it seems that both Germany and Russia are taking steps to secure the output, or a major part of it, for themselves. The mines are exploited by the Finnish company, Petsamon Nickel O/Y, which belongs to the British Mond Nickel Company. According to the *Deutsche Allgemeine Zeitung* the ore deposits extend through a range of hills 25 miles long. The Mond Nickel Company has held the concession since 1934, and production was projected to begin this year. The probable output is estimated at 200,000 tons of nickel ore a year, which were to be worked off partly in Britain and partly in the Finnish town of Kolosjoki, where the necessary plants were being constructed. According to the same paper Finnish copper production was not affected by the war, as the mines are situated in Central Finland, near Outukumpu and Kuusjärvi. The ore deposits there are estimated to amount to 30,000,000 tons, containing 800,000 tons of copper. They are being exploited by a Finnish State-owned company, the output in 1938 having been 1340 tons of copper, a considerable part of which went to Germany. The Reich is now making great efforts to increase her imports from that area.

Welding Cast Iron to Bronze

FOR joining dissimilar metals one of the simplest methods is to use the bronze-welding process. In the case of chemical plant, however, the finished product will probably have to resist the action of those corrosive fluids which attack brass or bronze. Obviously, a bronze-welded joint will not do, though the solution to the problem is quite simple, and is based on the same property of metals that makes bronze-welding possible. Briefly, it depends upon the fact that a metal of lower melting point tends to sweat to the clean, heated surface of a metal of higher melting point. An example of this type of work may be useful. A research laboratory required a piece of equipment for freezing a solution containing caustic soda. A vessel similar in design to an ice-cream freezer was designed, and, to resist the corrosive action of caustic soda it was decided that Monel metal be used for the container and that the joints be welded with

Monel welding rod. It was necessary to have a cast-iron plug in the bottom of the vessel through which a rotating arm would fit. The problem was how to weld the cast iron plug into the Monel hole. The solution was to use cast iron welding rod with a technique similar to that of ordinary bronze-welding. The melting point differential between cast iron (1176° C.) and Monel (1360° C.) made the job possible. The bottom of the container was preheated with the welding flame to permit expansion and annealing of the Monel. With the iron fitting in place heat was applied simultaneously to both plug and container. When the Monel reached a cherry red heat, the flame was concentrated on the iron plug to bring it to fusion temperature. Cast iron welding rod and flux were used to make the joint. There was a definite fusion between the cast iron rod and the cast iron plug, but the action between the plug and the Monel container was a sweating similar to the "tinning" action in bronze-welding. This gave a good union between the metals and a strong joint. For this type of work, the heat must be carefully controlled to carry the job through satisfactorily. Care must also be taken to remove surface oxides by the use of flux.

New Type of Copper

Dustless and Sliverless

AFTER a ten-year programme of research and development a new type of copper has been developed by the Phelps Dodge Copper Products Corp., New York. (*News Ed., Am. Chem. Soc.*, 1940, 18, 7, p.311).

The new copper, known as PDCP, is said to have greater conducting power, ductility, fatigue resistance, and surface quality than ordinary copper. It is made, under a patented process, without melting from electrolytic cathode copper, which is plastically converted by tremendous pressure in a reducing atmosphere at elevated temperature into smooth, dense copper bar, rod, strip, or other desired commercial shapes. Basically of the oxygen-free type, it is not melted after the electrolytic purification process. Hence the intrinsic purity of electrolytic cathode copper is not only retained but is greatly enhanced at the high temperature of the reducing gas used.

One of the principal difficulties of engineers and maintenance men concerned with copper windings in motors and transformers is the existence of surface imperfections in the copper, which may originate in the casting process and by vibration and magnetic stress eventually penetrate the insulation and cause failure by short circuits. In addition, slivers and oxides are more or less inherent in the hot-rolling process. The new method eliminates not only the casting process but also hot-rolling. It has given outstanding performance in high-frequency and high-voltage transformer windings, in high-tension and submarine cables, refrigeration, and air-conditioning installations. It is particularly applicable for service where severe vibration is a problem. Ductility far greater than ordinary copper permits sharper bends, easier forming, and drawing. The metal is said to approach the malleability of gold.

METAL ARC WELDING IN MILD STEEL

The revision of B.S. 538—Metal Arc Welding of Steel Structures—has been awaited by industry for some time and its publication is both welcome and opportune. It has been known that the main object of preparing this revision was to bring the standard into line with the conditions issued by the London County Council under which welding would be permitted in London. There is, accordingly, very much that is common to both documents, but the British Standard is somewhat more comprehensive in that it deals in greater detail with the important aspects of workmanship and testing.

Copies of the standard may be had from the British Standards Institution, 28 Victoria Street, London, S.W.1, price 2s. each (2s. 2d. post free).

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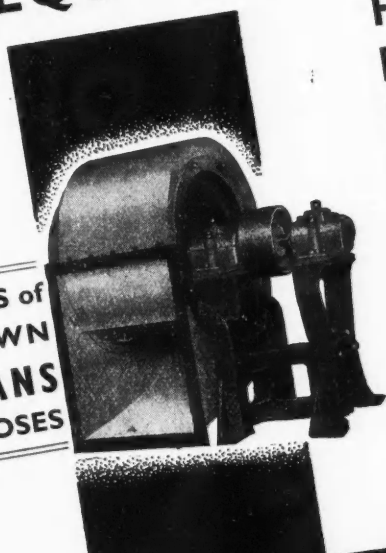
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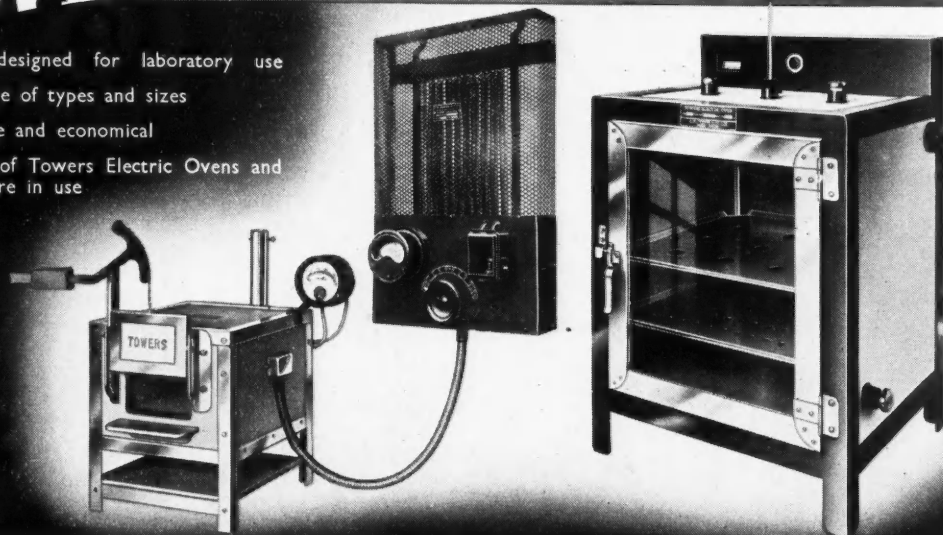
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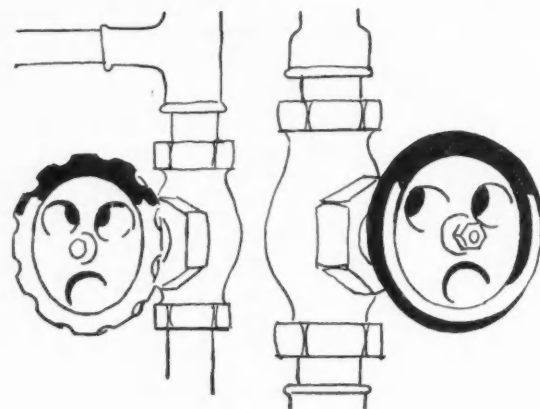
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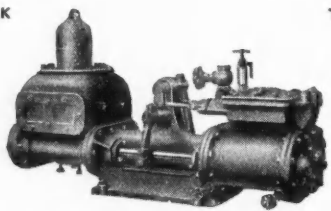
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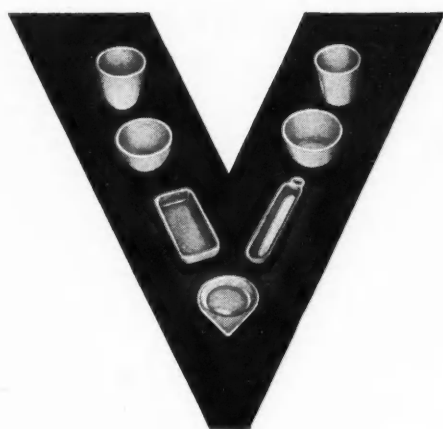
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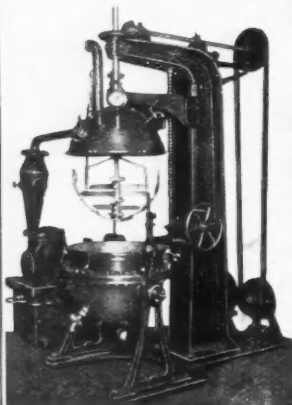
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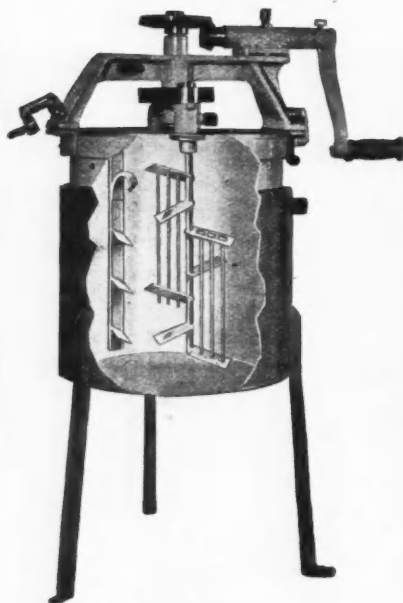
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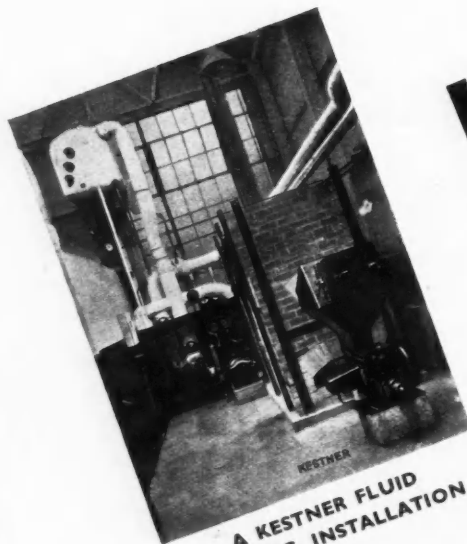


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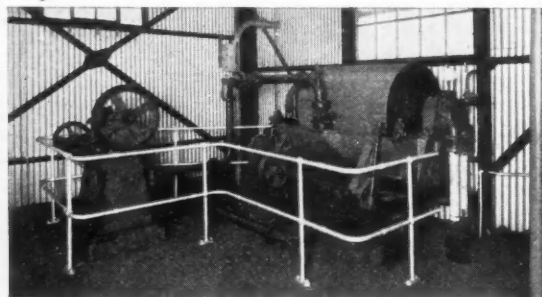
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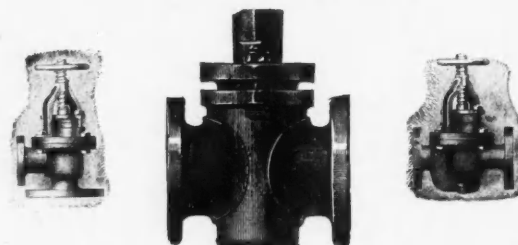
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